VIEWS OF PRE-SERVICE SCIENCE TEACHERS ABOUT INFORMAL LEARNING ENVIRONMENTS BEFORE AND AFTER SCIENCE AND TECHNOLOGY MUSEUM VISIT

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

BY

LEMAN ARAS ÖZDEMİR

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCİENCE
IN
MATHEMATİCS AND SCİENCE EDUCATİON

SEPTEMBER 2019

Approval of the thesis:

VIEWS OF PRE-SERVICE SCIENCE TEACHERS ABOUT INFORMAL LEARNING ENVIRONMENTS BEFORE AND AFTER SCIENCE AND TECHNOLOGY MUSEUM VISIT

submitted by **LEMAN ARAS ÖZDEMİR** in partial fulfillment of the requirements for the degree of **Master of Science in Mathematics and Science Education Department, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar
Dean, Graduate School of **Natural and Applied Sciences** _____

Prof. Dr. Ömer Geban
Head of Department, **Math. and Sci. Edu.** _____

Prof. Dr. Esen Uzuntiryaki Kondakçı
Supervisor, **Math. and Sci. Edu., METU** _____

Examining Committee Members:

Prof. Dr. Yezdan Boz
Mathematics and Science Education, METU _____

Prof. Dr. Esen Uzuntiryaki Kondakçı
Math. and Sci. Edu., METU _____

Assoc. Prof. Dr. Hüseyin Akkuş
Mathematics and Science Educaton, Gazi Uni _____

Date: 09.09.2019

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

Name, Surname: Leman Aras Özdemir

Signature:

ABSTRACT

VIEWS OF PRE-SERVICE SCIENCE TEACHERS ABOUT INFORMAL LEARNING ENVIRONMENTS BEFORE AND AFTER SCIENCE AND TECHNOLOGY MUSEUM VISIT

Aras Özdemir, Leman
Master of Science, Mathematics and Science Education
Supervisor: Prof. Dr. Esen Uzuntiryaki Kondakçı

September 2019, 102 pages

Informal learning environments are appropriate to support student centered education. There are real examples and problems in informal learning environments and social interactions and being active in applications increases motivation and interest of students. Thus, science becomes more enjoyable for students. If pre-service science teachers have knowledge about these environments, they can visit there in future during their profession. Therefore, it is important to explore views of pre-service science teachers about informal learning environments. The purpose of this study was exploring the views of pre-service science teachers about informal learning environments after visiting science museum in conjunction with method of science teaching course. This study was a qualitative research and data were gathered by conducting interviews. A total of 17 pre-service science teachers were interviewed before and after visiting Science and Technology Museum in Middle East Technical University (METU). Content analyses method was used in data analyses. Results of the study showed that instruction about field trips and integrating the Science and Technology Museum visit into the program of the science teaching methods course generally provided the pre-service science teachers to make more comprehensive

explanations and to give more detailed information about informal learning environments and additionally they generally developed positive views after visit.

Keywords: Informal Education, Pre-service Science Teachers, Out of school Learning, Science Museum

ÖZ

FEN BİLİMLERİ ÖĞRETMEN ADAYALARININ BİLİM VE TEKNOLOJİ MÜZESİ GEZİSİ ÖNCESİ VE SONRASINDA OKUL DIŞI ÖĞRENME ORTAMLARI İLE İLGİLİ GÖRÜŞLERİ

Aras Özdemir, Leman
Yüksek Lisans, Matematik ve Fen Bilimleri Eğitimi
Tez Danışmanı: Prof. Dr. Esen Uzuntiryaki Kondakçı

Eylül 2019, 102 sayfa

Okul dışı öğrenme ortamları öğrenci merkezli eğitimi desteklemek için uygun ortamlardır. Okul dışı ortamlarda gerçek nesneler ve sorunlar kullanılır, bununla birlikte özgürce sosyal etkileşim ve aktif olarak etkinliklere dahil olmaları katılımcıların motivasyonunu, ilgisini artırırken bilimi daha eğlenceli hale getirmektedir. Öğretmen adaylarının bu ortamlarla ilgili bilgi sahibi olmaları ilerde mesleğe başladıklarında bu tür etkinlikleri kullanmalarını sağlayabilir. Bu nedenle, öğretmen adaylarının okul dışı öğrenme ortamları ile ilgili görüşlerinin belirlenmesi ve hangi durumlarda geliştiğinin araştırılması önemlidir. Bu çalışmada, fen öğretimi uygulamaları dersi alan öğretmen adaylarının okul dışı öğrenme ortamları ile ilgili görüşleri incelenmiş ve ders kapsamında Orta Doğu Teknik Üniversitesi (ODTÜ) Bilim ve Teknoloji Müzesine gerçekleştirilen gezinin bu görüşlerini değiştirip değiştirmediği araştırılmıştır. Çalışma nitel araştırma olup, araştırmada kullanılacak veriler gezi öncesinde ve sonrasında 17 fen bilimleri öğretmen adayı ile yapılacak görüşmeler neticesinde elde edilip içerik analizi yöntemiyle analiz edilmiştir. Çalışmanın sonucunda alan gezileri ile ilgili dersin ve Fen ve Teknoloji Müzesi ziyaretinin genellikle öğretmen adaylarının daha kapsamlı açıklamalar yapmalarını ve informal öğrenme ortamları hakkında daha ayrıntılı bilgi vermelerini sağladığı tespit

edimiştir. Bunun yanı sıra öğretmen adaylarının pozitif görüşler geliştirdiği gözlemlenmiştir.

Anahtar Kelimeler: İnformal Eğitim, Fen Bilgisi Öğretmen Adayları, Okul Dışı Öğrenme, Bilim Müzesi

To my dear mother for her endless love and support

ACKNOWLEDGEMENTS

First of all, I would like to express my deepest and sincere gratitude to my supervisor Prof. Dr. Esen UZUNTİRYAKİ KONDAKÇI for her support and guidance throughout this study. I could not finish that study without her encouragements, motivation, patience and suggestions.

I would also like to thank to Prof. Dr. Yezdan BOZ and Assoc. Prof. Dr. Hüseyin AKKUŞ for their invaluable suggestions and comments on the committee.

I would like to express deepest thanks to my beloved husband Erol ÖZDEMİR for his supports, helps, patience, and understanding and to my dear son Yusuf Enes ÖZDEMİR for his greatest love.

Special thanks go to my mother Fatma ARAS for her support and patience during the most difficult times of that study. I always felt her care and love throughout my life. I am also grateful to my lovely father Hidayet ARAS, my sister Süeda ARAS and my brother Mustafa ARAS who always help me when I need. I would also like to thank to ÖZDEMİR family for their supports.

Lastly, I would like to thank to my closest friends who supported and believed in me to complete my thesis.

TABLE OF CONTENTS

ABSTRACT v

ÖZ vii

ACKNOWLEDGEMENTS x

TABLE OF CONTENTS xi

LIST OF TABLES xiv

1. INTRODUCTION 1

1.1. Background of the Study 1

1.2. Purpose of the Study 4

1.3. Significance of the Study 4

1.4. Definition of Terms 5

2. LITERATURE REVIEW 7

2.1. Theoretical Background of the Study 7

2.2. Informal Learning Environmets 13

2.3. Informal Learning Environments in Teacher Education Programs 18

2.4. Emprical Studies Related to Informal Learning Environments 19

2.5. Empirical Studies on Informal Learning Environments in Teacher Education 25

3. METHODOLOGY 33

3.1. Design of the Study 33

3.2. Research Question 34

3.3. Participants and Context of the Study 35

3.3.1. Setting of the Science and Technology Museum in METU 36

3.4. Data Collection Instrument and Procedure 37
3.5. Data Analysis 40
3.6. Validity and Reliability Issues of the Study 49
3.6.1. Credibility 49
3.6.2. Dependability 50
3.6.3. Transferability 51
3.7. The Role of the Researcher 51
3.8. Ethical Issues 52
3.9. Limitations of the Study 52
3.10. Assumptions of the Study 53
4. RESULTS 55
4.1. Venues of Informal Learning Environments 56
4.2. Significance and Benefits of Informal Learning Environments 59
4.2.1. Affective variables 59
4.2.2. Learning of students 61
4.2.3. Learning Environments 64
4.3. Disadvantages of Informal Learning Environments 66
4.4. Using Informal Learning Environments in Future as a Teacher 70
4.4.1. Learning of students 70
4.4.2. Developing positive attitudes 72
4.5. Assessment of Learning in Informal Learning Environments 73
4.5.1. Types of assessment 73
4.5.2. Time of assessment 74
4.6. Science and Technology Museum Trip 75

4.6.1. Positive sides of Science and Technology Museum trip 76
4.6.2. Negative sides of Science and Technology Museum trip.....77
4.6.3. Ideas after Science and Technology Museum trip.....79
4.7. Summary of Results 80
5. DISCUSSION, CONCLUSION AND IMPLICATIONS 83
5.1. Discussion 83
5.2. Conclusion.....89
5.3. Implications and Suggestions for Practice and Future Research 90
REFERENCES.....93
APPENDICES
A. INTERVIEW QUESTIONS.....101

LIST OF TABLES

TABLES

Table 3.1. Coding Protocol 42
Table 4.1. Total Frequencies of the Themes 56
Table 4.2. Frequencies for the Venues of Informal Learning Environments 57
Table 4.3. Frequencies for the Contents of the Venues 58
Table 4.4. Frequencies of Affective Variables 61
Table 4.5. Frequencies of Aspects related to Learning of Students under Significance and Benefits Theme 62
Table 4.6. Frequencies for the Learning Environments 65
Table 4.7. Frequencies for Disadvantages of Informal Learning Environments. 66
Table 4.8. Frequencies of Aspects in Instructional Difficulties 67
Table 4.9. Frequencies of Aspects related to Learning of Students under Using Informal Learning Environments in Future as a Teacher Theme 71
Table 4.10. Frequencies of Aspects related to Developing Positive Attitudes in Students 72
Table 4.11. Frequencies for the Types of Assessment 74
Table 4.12. Frequencies for the time of assessment 75
Table 4.13. Frequencies of Positive Sides of Science and Technology Museum Trip 76
Table 4.14. Frequencies of Negative Sides of Science and Technology Museum Trip 77
Table 4.15. Frequencies of Pre-service Science Teachers'Ideas after the Science and Technology Museum Trip 79

CHAPTER 1

INTRODUCTION

The background, purpose, and significance of the study and definition of terms are presented respectively in this chapter.

1.1. Background of the Study

After the Institute for Learning Innovation was established in 1986, the importance of free-choice learning started to be understood and number of research on that topic increased quickly (Rennie, 2016). People spent most of their life out of school contexts (Fenichel & Schweingruber, 2010; National Research Council [NRC], 2009). Out of school contexts provide people many opportunities to learn and experience science according to their interests in an enjoyable way (Rennie, 2006).

Cognitive and sociocultural perspectives have an impact on the informal learning environments to support science learning (NRC, 2009). How these perspectives are related to learning in informal learning environments could be explained by defining characteristics of these environments. Being active in the learning process, learning by doing and trying experiments, meaningful learning, and engaging in the social context throughout learning are the main points of constructivism (Driscoll, 2005). Constructivism promotes higher-level outcomes such as generalizing, synthesizing, analyzing, and evaluating since it provides learners to construct their own learning (Airasan & Walsh, 1997). Hein (1995) pointed out the matching points of constructivism with the informal learning environments: There is no strict sequence in the learning process; there are different and diverse materials for meaningful learning, and visitors could connect their prior knowledge to new

experiences. Social constructivism suggests that the socialization and enculturation in the learning and knowledge gain could not be separated from its social context (Airasan & Walsh, 1997; Anderson, Lucas & Ginns, 2003; Osborne, 1996). Meaning could be constructed through social interactions and mediators such as tools, devices and symbols in museum learning and these properties match with the social constructivism (Schauble, Leinhardt & Martin, 1997).

Common terms in the literature used for informal learning environments are non-formal learning, informal education, informal setting, free-choice learning, and free-choice environment (Rennie, 2006; Tal, 2012). Authentic and real-world experiences in informal environments could change the perspectives of individuals from all ages through the life span (Fenichel & Schweingruber, 2010). If learners appreciate science more by seeing it in a broader context and realize that science is a human activity, then science education can be seen as more appropriate and attractive (Dillon, 2012).

Informal learning environments include everyday informal learning environments (watching TV, reading books, etc.); designed environments (museums, science centers, libraries, etc.) and programs (after school activities, citizen science activities, etc.) (Fenichel & Schweingruber, 2010). Experts claim that these environments could attract and motivate students in a way that is different from formal classrooms about science learning since they include real-world and natural phenomena in a rich, relax and non-grading environment (Ramey-Gassert, 1997). Objectives of informal learning environments are summarized as "sparking interest and excitement, understanding scientific content and knowledge, engaging in scientific reasoning, reflecting on science, using the tools and language of science, and identifying with the scientific enterprise" (Fenichel & Schweingruber, 2010, p.27).

Cognitive, physical, and emotional engagements occur in informal learning environments; participants could have direct interactions with the natural or designed phenomena according to their choices and there are multidimensional opportunities to learn science actively (Fenichel & Schweingruber, 2010). Informal learning environments such as museums, science centers, zoos, aquariums, and botanic gardens

are effective for learners to obtain competence, knowledge, skills, and attitudes of science when they are integrated with the classroom objectives. Students' interest and curiosity could be drawn with the opportunities of open-ended, pleasant and continuous learning in an innovative, social and cultural context of science and technology in informal environments (Dopico & Kim, 2016). To sum up, informal learning environments provide interest, motivation, encouragement and enjoyment (Ramey-Gassert,1997); increase the knowledge of science contents (Dillon, 2012); promote physical, social, motor skills and attitudes towards science (Avraamidou, 2014; Sasson, 2014). Interest, positive attitudes or knowledge in science could be supported in the school and many different environments, however, it is important to ask that how the connection of formal and informal environments could contribute to science learning (Fenichel & Schweingruber, 2010).

Linking the experiences in out of school learning to school curriculum enhances science learning and provides pupils to understand school are not just places for learning and there are many opportunities to contact with the scientific experiences (Fenichel & Schweingruber, 2010). Teachers and students in these environments do not have to obey the strictly planned curriculum and therefore, students and teachers do not feel pressure for achieving the goals and assessing the outcomes in informal environment, moreover, potential rich resources and attractiveness of the informal environments could deepen science learning and scientific literacy among students (Dopico & Kim, 2016).

Researchers concluded that recent teacher education programs are not effective to develop teaching abilities of pre-service science teachers since they especially do not have adequate time and materials to teach science and teachers confirmed this inadequateness by reporting their disabilities when they entered the class (Adams & Gupta, 2012; Dai, Hestness, Marbach-Ad, McGinnis, Katz, & Riedinger, 2012;).

Informal learning environments are more appropriate for preparing pre-service science teachers to teach science than formal teacher education programs since there are diverse teaching materials, contexts and learners (Fenichel & Schweingruber, 2010). Additionally, pre-service teachers could develop their motivation and teaching

skills and they could have positive attitudes towards science and to teach science (Adams & Gupta, 2012; Avraamidou, 2014).

1.2. Purpose of the Study

The purpose of this study was to investigate the views of pre-service science teachers about informal learning environments before and after visiting Science and Technology Museum in Middle East Technical University (METU). I aimed to answer the following question in the study:

> What are the views of the pre-service science teachers about informal learning environments before and after visiting Science and Technology Museum in METU in conjunction with the Methods of Teaching Sciences I course?

1.3. Significance of the Study

Pre-service and in-service programs in science teacher education do not generally include informal learning environments (Hofstein & Rosenfeld, 1996). However, the need for varying teaching approaches in a more interesting and engaging way for students to lead meaningful learning have been indicated in the recent research and curriculum approaches (Coll & Coll, 2018). Pre-service teachers who are developing teaching experiences in the context of an informal science organization could have the opportunity to practice different techniques on the same topic with different types of learners and their pedagogical and teaching skills develop and additionally, pre-service teachers could be able to reflect themselves as science teachers (Tal, 2012). If informal learning environments are integrated into science teacher education programs, they could make contributions to develop a learner-centered science education and identities of prospective teachers are constructed in a learner-centered way (Adams & Gupta, 2017).

Investigating the views of teachers about learning and teaching science in general and learning and teaching science within the informal environments in

particular, a missing link on connecting science to students' everyday lives and teaching science in different and wider context could be provided (Avraamidou, 2015). It is needed to understand the ideas of pre-service teachers about informal learning environments, their opinions for science instruction in informal environments, and how they would use informal environments in the future for learning of students (Asim, Koo, Lee & Subramaniam, 2018).

This study is important since it presents an overall investigation of the views of pre-service science teachers about informal learning environments. This investigation provides a detailed picture on the views of pre-service science teachers about informal learning environments before and after visiting the Science and Technology Museum along with a science teaching method course. Therefore, this study could make contributions to teacher education programs about using informal learning environments in training pre-service teachers. This study supports that if pre-service science teachers can have ideas about informal learning environments they could try to use these environments. Science museum experience could enhance the ideas of pre-service teachers about informal learning environments. They could learn how to apply field trips and how to integrate informal learning environments to their curriculum objectives and additionally, they could have ideas about using informal learning environments in the future. Teacher educators could understand that how visiting a science and technology museum contributes to pre-service science teachers' ideas about informal learning environments and teacher educators could think of enhancing the teacher education programs with the opportunities of informal learning environments.

1.4. Definition of Terms

Informal learning environments: Physical contexts that are outside of formal schooling (Avraamidou, 2015). In this study, informal learning environments term is used to define out of school environments that could promote science education.

Science Centers: Science center is a type of museum that provides opportunities to engage with science through hands-on activities, interactive exhibits, and direct experience with scientific phenomena (Bell, Reeve, & Zimmerman, 2010, p.479).

CHAPTER 2

LITERATURE REVIEW

This chapter explains the theoretical background of the study, provides information about informal learning environments and teacher education in these environments and presents empirical findings of the studies in the related literature.

2.1. Theoretical Background of the Study

Learning is a complex phenomenon and it is not possible to explain learning by using a single theory, therefore; many different learning theories were developed in the twentieth century (Agarkar & Brock, 2017). Theory foregrounds the question and problems of the research topic and maintains the central aspects of research findings and also provides coherence within the related topics, therefore, a broad and well-defined theoretical framework is needed to develop a generative and generalizable research agenda on museum learning (Schauble, Leinhardt, & Martin, 1997). Anderson et al. (2003) also stated that many studies about museum learning did not use a theoretical foundation, however, recent studies relate learning in science museums to constructivist view and particularly social construction of knowledge framework (Rennie, 2014). Similarly, according to the National Research Council (NRC, 2009), cognitive and sociocultural perspectives mostly affected the informal learning environments to support science learning. Therefore, in this section, the principles of constructivism and how constructivism relates to learning in science museums will be explained.

Rennie (2014) also stated some characteristics of informal learning environments according to the definition of learning. Learning is a personalized,

contextualized and cumulative process and informal learning environments are appropriate for those properties. Learning is personalized since people are different from each other and every person has unique learning, therefore, freedom of the informal learning environments provides learners to have different experiences and outcomes. Additionally, learning is contextualized because of social interactions and interactions with the materials in the context, therefore, informal learning environments provide construction of knowledge in a social and enriched context. Lastly, learning is a cumulative process and it takes time in other words, today's learning affects tomorrow's learning. Therefore, the knowledge that is gained from informal learning contexts will be remembered and affect the future and previous learning of a concept.

Constructivism is based on the view that learners construct their knowledge by connecting their existing knowledge with their prior knowledge (Agarkar & Brock, 2017; NRC, 2009). Constructivists reject the old view of knowledge in which knowledge is accepted as fixed and independent of the learner and truths are in the outside environment of the learner, therefore, if someone acquires the truth, he or she gets more knowledge about a subject area (Airasan & Walsh, 1997). Constructivism explains attaining, developing and using cognitive processes and rejects the old view of knowledge which claims that truths are subjective realities (Schauble, Leinhardt, & Martin, 1997). Constructivists claim that people produce knowledge according to existing beliefs and experiences and therefore, knowledge is tentative, subjective, and personal (Airasan & Walsh,1997). Knowledge is viewed not as a set of universal truths, but as a set of working hypotheses, thus constructivists believe that knowledge can never be justified as true in an absolute sense (Glasersfeld, 2007; Schauble, Leinhardt, & Martin, 1997; Southerland, Sinatra, & Matthews, 2001).

Meaning is built in people's minds by interacting physically, socially, and mentally with the environment they live in and their experiences become meaningful by rebuilding the internal knowledge according to these physical, social, and mental interactions (Swan, 2005). All learning occurs in the individuals' mind by accommodating the internal structures to continuously developing and changing stores

of knowledge and therefore, "learning is an active process and all knowledge is unique to the individual, whether acquired from lecture and text or discovered through experience" (Swan, 2005, p.2). Duffy and Cunningham (1996) also summarized the general view of constructivism as "learning is an active process of constructing rather than acquiring knowledge and instruction is a process of supporting that construction rather than communicating knowledge" (p.2). Learners come to science class with their prior knowledge which will affect their later knowledge (Agarkar & Brock, 2017). In other words, knowledge could not be constructed as independent from the learner and individuals create their knowledge by using their existing beliefs and experiences (Schauble, Leinhardt, & Martin, 1997; Southerland, Sinatra, & Matthews, 2001). It is needed to encourage interactions of students' existing knowledge with the new experiences and this is different from the classical transmission model in which teachers explain subjects to students' minds directly only by telling (Airasan & Walsh, 1997). Scientific knowledge could not be transmitted directly from teachers to learners; therefore, learners must be active in the class rather than sitting and listening to their teacher. Similarly, teachers must not impose knowledge but try to guide students' learning (Bodner, 1986). Teachers should not be responsible for the learning of students primarily, however, students should have the responsibility of their learning and teacher should coordinate and criticize students' constructions (Airasan & Walsh, 1997). "Constructivists claim that they emphasize autonomy as opposed to obedience, construction as opposed to instruction and interest as opposed to reinforcement" (Airasan & Walsh, 1997, p.446).

Constructivist principles indicate that it is not possible to standardize learning, but standardization of instruction could be possible, therefore, we, as educators, should create virtual and active learning environment and these environments must be learner-centered, knowledge-centered, assessment-centered, and community-centered (Swan, 2005). Learner-centered environment indicates the uniqueness of learners' knowledge, skills, attitudes, and beliefs related to experiences; being knowledge-centered indicates meaningful learning with understanding topics through broad explorations; being assessment-centered reflects giving continuous and meaningful

feedback to learners; and finally being community-centered represents learning socially in communities and cultures (Swan, 2005).

Anderson et al. (as cited in Driscoll, 2005, p.407) stated the points of constructivism as:

- only the active learner is successful
- learning from examples and learning by doing enable learners to achieve deep levels of understanding
- learning with understanding is what is desired, not rote learning,
- the social structure of the learning environment is important.

The rapid acceptance of constructivism in the educational field can be explained by stating today's educational needs and characteristics of constructivism together (Airasan & Walsh,1997). Classical perception of teaching in schools is generally based on rote outcomes and does not emphasize thinking and higher-order skills and therefore, it is not sufficient for meeting the intellectual and occupational needs of many students (Airasan & Walsh,1997). Skills such as generalizing, analyzing, synthesizing, and evaluating become important with the non-rote instructional outcomes. Constructivism supports higher-order skills by giving responsibility to students for constructing their knowledge, meanings, and interpretations; meanwhile, it encourages teachers to coordinate and evaluate students' constructions instead of being supplier of knowledge (Airasan & Walsh,1997).

Driscoll (2005, p.394) stated conditions for constructivist learning as:

1. Embedded learning in complex, realistic, and relevant environments.
2. Provide for social negotiation as an integral part of learning.
3. Support multiple perspectives and the use of multiple modes of representation.
4. Encourage ownership in learning.
5. Nurture self-awareness of the knowledge construction process.

In other words, Driscoll (2005) emphasized the properties of constructivist learning as presenting simple tasks to learner prevents them to solve complex real-life problems therefore, students must be faced with these complex situations in their educational

life; collaboration and social interactions provide high mental processes; if different sensory modes are used to view the same content, learners could see the different aspects of that content; learners should determine and manage the process and needs of their learning; constructivist learning promotes to help learners to understand their knowledge construction process.

The constructivist view of learning explains learning in museum since it emphasizes individuals' prior knowledge and active involvement in the construction of knowledge. In addition, it states the dynamic nature of knowledge construction; prior knowledge could be changed and restructured with the experiences in the museum setting (Anderson, Lucas, & Ginns, 2003). The constructivist view emphasizes the unique nature of learning and indicates two visitors will have different experiences and construct different knowledge from the museum activity. Teachers could turn that to an opportunity for instruction by listening carefully and exploring students' reactions to museum and exhibits in it (Anderson, Lucas, & Ginns, 2003). There is not any strict curriculum for profession in the museums and museums provide variability and different opportunities in the learning. Therefore, learning of the visitors is unique for them. In addition, retention is high when students learn in museums (Schauble, Leinhardt & Martin, 1997). Constructivist museum exhibits encourage visitors to make inferences about the exhibition and Hein (1995) summarized the appropriateness of constructivism to museums as "the lack of predetermined sequence, use of multiple learning modalities and opportunity for the visitors to make connections between familiar and unfamiliar concepts" (p.22).

Educators claim that one of the effective ways to learn science is to engage in scientific activities at first hand (Rumjaun, 2017). In this way, students get scientific experiences with making observations, collecting data, performing experiments that are similar experiences to the scientists which could be named as authentic science education which has become more important for learning science in recent years and informal learning environments such as museums could provide ill-defined problems as in the laboratories of scientists that could not be provided in the classroom environments (Gilbert & Priest, 1997). Basic characteristics of informal learning

environments which encourage learning are stated by Fenichel and Schweingruber (2010, p.5);

- engaging participants in multiple ways, including physically, emotionally, and cognitively,
- encouraging participants to have direct or media-facilitated interactions with phenomena of the natural world and the designed physical world in ways that are largely determined by the learner,
- providing multifaceted and dynamic portrayals of science,
- building on the learners' prior knowledge and interest,
- allowing participants considerable choice and control over whether and how they engage and learn.

As a result, it seems that constructivism fits well to explain learning in museums. However, a particular form of constructivism, social constructivism, is also appropriate to explain how learning occurs in science museum with the emphasis on social interactions (Anderson, Lucas, & Ginns, 2003). According to social constructivism, knowledge could not be thought as independent from its social context (Airasan & Walsh, 1997); instead, knowledge is constructed socially (Osborne, 1996; Schauble, Leinhardt, & Martin, 1997). Social constructivism puts forward the enculturation in science education and states that novices can learn the community knowledge from the experts of that community (Osborne, 1996). Swan (2005) emphasizes the importance of social activity in learning process by stating that "Learning is essentially a social activity, that meaning is constructed through communication, collaborative activity, and interactions with others. It highlights the role of social interactions in meaning making, especially the support of more knowledgeable others in knowledge construction" (p.5). Museums do not give priority to subject matter knowledge but emphasize the terms such as enculturation, development, attitude and socialization. Construction of meaning through the interaction of people in the social environment and the mediators such as tools, talks, activities, signs, and symbols in these environments is very appropriate for museum

settings which include symbolic and cultural meanings, signs, and tools (Schauble, Leinhardt, & Martin, 1997).

Social constructivism can guide the museum learning in many ways that are consistent with the characteristics of museum learning; "variability of learning, the process of learning and the role of learning in personal history and the pursuit of meaning" (Schauble, Leinhardt, & Martin, 1997, p.4). Variability in museum learning reflects experiences, knowledge, and interests of visitors, kinds of activities and pathways and contributions of meanings to the visitors' ways of knowing. The process of learning explains that social constructivism focuses not only on outcomes of learning in the museum but also it emphasizes forms and functions of visitors' activities. Social constructivism also emphasizes the developmental way of museum learning considering changes in visitors' minds throughout their life span; effects of museum learning for long-lasting. Meaning making is also important in social constructivism and there may not be any environment that will provide more self-conscious learning than museums (Schauble, Leinhardt, & Martin, 1997). Results of Glackin (2016) about the relationship between secondary science teachers' epistemological beliefs and their outdoor activity practice during a professional development program reveals the relationship between informal science learning environments and social constructivism. Teachers who had social constructivist beliefs were successful to teach in outdoor environments, however, teachers who had traditional learning beliefs were not successful while teaching outside.

2.2. Informal Learning Environmets

Nowadays, learning is viewed as a life-long process. According to Fenichel and Schweingruber (2010), there is an estimation that individuals do not spend more than 9% of their lives in schools. We actually know that school courses include mathematics and literacy rather than science; therefore, school opportunities are not enough for teaching and learning science without contributions of out-of-school environment (NRC, 2009). The NRC report (2009) states that all people from different

ages are surrounded by science-related subjects in everyday life and therefore, they need to understand these subjects. Rennie (2006) pointed out that "Now with more time for leisure in our society, we have the luxury of learning for interest rather than necessity, for satisfying our curiosity and enjoying ourselves. Recognizing the educational value of out of school learning is part of revolution because there are so many opportunities to learn" (p. 115).

Opportunities of informal learning environments are accessible for many years, however, recent and lifelong effects of informal learning environments on children and adults have been examined recently by the educators (National Science Teachers' Association [NSTA], 2015). There has been a growing interest in informal science learning through the last two decades as a result of their role in complementing formal science education (Dierking & Tal, 2014; Popovich & Zint, 2012).

Learning that occurs outside of school or other educational institutions has common terms as informal learning; non-formal learning; informal education, informal setting; free-choice learning, free-choice environment; learning in out of school contexts, settings or environments to describe opportunities of out of school contexts (Rennie, 2006; Tal, 2012). There are some basic differences in the literature about the terminology. To illustrate, Eshach (2007) divided out of school learning as non-formal learning and informal learning to understand their characteristics well. Non-formal learning environments are organized places such as industry, botanical gardens, zoo, planetarium, aquarium, scientific centers, and museums, however, informal learning occurs spontaneously in everyday environments such as street, playground, and home. In a similar manner, Rumjaun (2017) divided educational visits into two parts as formal visits which are planned and organized into a format such as science museums, research centers and informal visits which are less structured and provide students self-control of their learning process. In the present study, I used informal environment to refer to the designed environments that could be used for educational purposes and link informal education to formal education.

Dierking (1991) states that learning is learning and it is not needed to differentiate learning as formal, informal or else since learning is affected from settings but on the other hand, social interactions, personal knowledge, beliefs, and attitudes also have an influence on the learning (as cited in Anderson et al., 2003; Eshach, 2007). Settings do not affect learning completely however, informal learning environments provide different settings to experience different learning outcomes (Rennie, 2006). Informal environments can be categorized into three parts (Fenichel & Schweingruber, 2010):

1) Everyday informal environments: Watching TV, reading newspapers, magazines or books; searching online; playing educational computer games; having conservations; pursuing one's hobby; volunteering for an environmental cause.

2) Designed environments: Museums, science centers, planetariums, aquariums, zoos, environmental centers, libraries.

3) Programs: 4-H programs, museum science clubs, citizen science activities, after school activities.

Linking school experiences with out of school experiences promotes science learning by helping students to understand there are opportunities to participated in science all around them (Bozdoğan, 2008; Fenichel & Schweingruber, 2010; Kisiel, 2014). "Informal science education environments provide students with unique, engaging science learning opportunities and classroom teachers with a wealth of science teaching resources" (Ramey-Gassert, 1997, p. 433). NRC (2009) reported the objectives for learning in informal learning environments that summarizes the capabilities of learners who take part in informal learning environments;

> Strand 1: Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.
>
> Strand 2: Come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science.

> Strand 3: Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world.
>
> Strand 4: Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.
>
> Strand 5: Participate in scientific activities and learning practices with others, using scientific language and tools.
>
> Strand 6: Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science. (p. 43)

Strands 1 and 6 are distinctive features of informal learning environments and other strands are also objectives for learning science in formal schooling (Fenichel & Schweingruber, 2010). Characteristics of informal learning environments support these objectives. Attendance is not an obligation in informal environments; there is not a strict curriculum, memorization of the subjects, competition between participants and grading; interaction and active involvement with real things occurs; informal science environments provide learner-centered education and additionally, social interactions take place freely (Ramey-Gassert, 1997). As a result of these characteristics, informal learning environments provide interest, motivation, encouragement, and enjoyment to participants (Avraamidou, 2014; Behrendt, 2017; Bozdoğan, 2008, Ramey-Gassert, 1997; Rennie, 2006;. Malone (2008) also summarized the results of experiences of school children in out of school as an increase in their knowledge and skill acquisition, physical, social, and motor skills; improvement in their attention, self-concept, self-esteem and mental health; and positive change in their attitudes towards environment (as cited in Dillon, 2012). Avraamidou (2014) also described these experiences as, "a wide and demanding range of scientific knowledge, knowledge about nature of science, skills, and attitudes towards science that are developed not only in school but also in out of school settings"

(p.824). Sasson (2014) stated that strong opportunities are important to have an effect on students' attitudes or interests and these opportunities can be pointed as allowing them to see what real scientists do and to try hands on activities. However, school contexts are not appropriate for realizing these opportunities and therefore, extracurricular opportunities in out of school contexts can provide authentic science activities and they are needed to motivate students. Meaningful and contextual learning and learning abstract concepts in science; motivating students to science by increasing the interest and curiosity; encouraging student-student and student-teacher interactions; and as a most important dimension developing science process skills of students such questioning, observing, recording systematically; and providing concrete understandings of abstract concepts are opportunities of educational visits as stated by Rumjaun (2017). As a summary, outcomes of learning in informal environments that are highlighted in the literature have generally these diverse topics; affective, social, and behavioral gains that in turn affect cognitive gain; conceptual and meaningful learning and enhancing thinking skills (Tal, 2012).

In the field of informal science education, most of the studies are related to museums (Çavuş, Kaplan, & Topsakal, 2013, Rennie, 2006). Rennie (2006) defined museums considering International Council of Museums as "a nonprofit making, permanent institution in the service of society and its development, and open to the public, which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environments" (p.131). According to this definition, other designed environments such as science centers, planetariums, aquariums, zoos, and libraries can be categorized as museums. Field trips to these designed environments are the most common way of linking school and non-school environment and they are journeys generally related to a curriculum subject (Fenichel & Schweingruber, 2010). Well-planned field trips increase students' positive attitude toward science and their information related to the subject (Ramey-Gassert, 1997). Fenichel and Schweingruber (2010) described the value of field trips with four factors which are

advance preparation, active participation in museum activities, teacher / chaperone involvement during the field trip and reinforcement after the field trip. Advance preparation includes teacher and student preparation both, teacher must inform the students and give worksheets to use during the trip, active participation must be provided by encouraging students with the help of teachers, teacher and institution's staff member have responsibility to manage the trip effectively and lastly, post-visit activities must be done to provide connection between curriculum and activities in the trip as a reinforcement (Fenichel & Schweingruber, 2010).

If there is learning, there must be assessment and evaluation about that process, however, the informal science learning process is difficult to assess because of its characteristics, informal learning is individualized and could not be assessed using standard methods such as grades and scores (Ramey-Gassert, 1997). Open-ended questionnaires, structured and semi-structured interviews, focus groups, participant observation, journaling, think-aloud techniques, visual documentation, and video and audio recording techniques are used generally to gather the specific and unique data related to cognitive and also non-cognitive outcomes of learning (Fenichel & Schweingruber, 2010, Tal, 2012).

It could be the best way to prepare projects with scoring rubrics for students to demonstrate their learning by combining the science content in the classroom and informal learning environments such as museums (Ramey-Gassert, 1997). Additionally, activity sheets that are given to students by educators provide to keep students on task (Dillon, 2012).

2.3. Informal Learning Environments in Teacher Education Programs

"Worldwide science education reforms in quality teacher preparation and professional development programs are needed to recognize the central role of teachers in supporting and developing scientific literacy" (Dai, Hestness, Marbach-

Ad, McGinnis, Katz, Riedinger, 2012, p.1097). Teachers reported the inadequateness of teacher education programs when they started to teach in the class and therefore, informal learning environments could be a transformative way for reforming teacher education programs by linking them with formal science learning environments (Dai et al., 2012). Traditional teacher education programs do not have enough time and opportunity for enhancing the epistemological and ontological views of pre-service teachers about teaching and learning, teachers do not know what they will do when they are confronted with diverse learners and situations (Adams & Gupta, 2012).

Informal learning environments are accepted as ideal places for teacher education programs since they are learner-centered and there are rich settings with different teaching materials and therefore, teacher education programs should include informal learning environments to provide content knowledge and pedagogical skills, and to develop pre-service teachers' usage of teaching materials (Fenichel & Schweingruber, 2010). Informal learning environments provide teachers to identify students' prior knowledge and enhance students' knowledge in multiple ways. Therefore, pre-service teacher education courses must emphasize using informal learning environments to enrich the school curriculum (Anderson, Ginns, & Lucas, 2003). Teachers' interest, motivation, engagement and attitudes towards science could be improved with using informal environments in their preparation programs (Avraamidou, 2014).

To summarize; contribution of informal learning education to formal teacher preparation provides many benefits such as affective benefits; focusing on active and learner centered learning; experiencing different teaching strategies with diverse learners, getting different perspectives about teaching and learning science, and developing the professional, pedagogical, and content knowledge skills (Adams & Gupta, 2012; Avraamidou, 2014; Dai et al., 2012).

2.4. Emprical Studies Related to Informal Learning Environments

National and international studies about informal learning environments will be summarized in this part of the study. A body of studies in the literature stress the characteristics and important features of informal learning environments, while others focus on the effects of informal learning environments on learning skills, perceptions, and affective variables such as attitude, interest, and motivation.

Regarding the effect of informal learning environments, Denson, Hailey, Householder, and Stallworth (2015) utilized qualitative research methodology to study the effects of informal learning environments on underrepresented students' STEM careers. The researchers used focus groups that were selected from the MESA (Math, Engineering, Science Achievement) Program. A total of 28 MESA students from five different public high schools in California formed five focus groups. The researchers conducted interviews with open ended questions and used the grounded theory as a method of analysis. Based on the responses, they summarized eight themes related to informal science learning environment which are (a) informal mentoring, (b) makes learning fun, (c) time management, (d) application of math and science, (e) feelings of accomplishment, (f) builds confidence, (g) camaraderie and (h) exposure to new opportunities.

Sasson (2014) studied informal learning environments considering affective variables. In order to examine the role of pre-academic center on students' attitudes towards science and self-efficacy, Sasson (2014) conducted a study with 750 middle-school students. There were two types of program: The first program, called "Science Research Program" focused on scientific thinking skills and included 600 students. Students in this program engaged in the scientific experience. They learned the process of scientific research such as formulating research question, data collection related to a science topic and then they were expected to prepare a science poster about their scientific research. They worked in small groups throughout 50 academic hours per year. The other program called "Preparation for Academia Program", consisted of 150 students. Students in this program attended introductory science and mathematics courses. Then students were encouraged to continue in regular college classes. They gained academic credits to prepare a high-level science project as a part of their school

exam. They received 120 academic hours per year. Data were collected using a five-point Likert scale questionnaire, CARS-Changes in Attitudes about the Relevance of Science Questionnaire. At the end of the study, the findings showed that students' attitudes towards science and self-efficacy increased in both programs, however, Preparation for Academia Program was more effective since it includes more academic hours. As a result, attitude change in informal environments should be examined through long periods of time. Gilbert and Priest (1997) studied long term memories of school field trips. They interviewed with 128 people about their school field trips that occurred in their early years of education. Participants are divided into three parts as nine and ten years old group, thirteen and fourteen years old group, adults in their twentieths and older group. Results of the study indicated that 96% of the people recalled a school field trip experience most frequently occurred in the natural sites and centers and additionally, 98.4% of the participants could remember at least one event or thing specific to trip and three quarters of the recalls are related to a content or subject matter and this is an evident about meaningful learning occurred in these school field trips. Similarly, Yanowitz (2016) studied the long-term role of a science camp on students' perceptions about science. A total of 124 students attended the two-day long forensic science program which included scientific activities related to forensic science. Forensic science was chosen as content since it included many other scientific disciplines. Students were grouped as ten students and 3-4 teachers per group. 7^{th} and 12^{th} grade teachers were educated for the program. Pre and post surveys were applied to measure self-efficacy with a Likert type self-efficacy scale. Another five-item scale was constructed to measure students' engagement in the activities after the camp and also students were expected to write a short essay about long lasting effects of summer camp to use as qualitative data. Responses of scales were averaged to get a single score and scores analyzed with repeated measures ANOVA. Qualitative data analyzed by content analyses. Results indicated that science camp made positive and continuing influence on the participants' perceptions of science and their self-efficacy increased immediately after the camp and went to higher levels after one year later.

Newell, Moreno, Tharp, and Zientek (2015) implemented an after school program which followed a curriculum developed by The Center for Educational Outreach at Baylor College and supported by the National Institute of Allergy and Infectious Diseases in London. There were 13 inquiry-based activities in the curriculum. These activities aimed to increase students' knowledge about microorganisms, the spread of diseases and general scientific terms, as well as their science skills such as collecting data and drawing graphs. The after school program lasted a semester and each activity lasted 45 minutes. The participants were 63 urban students in fourth and fifth grades. In order to collect data, Simpson-Troost Attitude Questionnaire and a multiple-choice assessment related to subjects were administered to the students as pre and post-test. As a result of the study, students' science content knowledge increased significantly. Students' enthusiasm and academic preparedness for additional science coursework improved. Moreover, students' perception of self-directed efforts enhanced.

Regarding museums, Balgopal, Boyd, McMeeking, and Weinberg (2016) studied on informal traveling science museum program that was created by a physic professor and included over one hundred interactive exhibits related to physics concepts. A total of 624 students (96 primary, 110 intermediate, 418 middle school students) from three schools participated in the study. Students interacted with the exhibits by themselves through 45-90 minutes. Data were gathered by the questionnaires after the visit. Results indicated that students reported that their science interest and knowledge gains increased. Ertaş, Şen, and Parmasızoğlu (2011) investigated whether 9th grade students could relate the unit of energy topics to daily life after out of school activities. A total of 58 Anatolian High School students visited Energy Park in Ankara after the energy unit was taught in the class. The students were divided into two groups and two counselors, one researcher, and one teacher accompanied students during the trip. All students observed the exhibits, made some experiments with counselors, and counselors made a demonstration in the Energy Park. Additionally, the students watched an animation about the production of energy and made a discussion about the animation in the class. A questionnaire which

included 12 open-ended questions was administered to the students before and after the trip. Results showed that the level students could relate energy topics to daily life improved and their understanding of the energy unit developed after the Energy Park visit.

Behrendt (2017) conducted a qualitative evaluative case study that explored the views of two science club advisors and teachers of a high school that includes 122 students through interviews. The science club had interesting activities such as placing dry ice in plastic milk jugs, placing a peep marshmallow in a vacuum pump, and building gliders. In addition, the science club program included three field trips to provide students with enjoyable scientific activities and interesting experiences and to increase students' awareness of science in everyday life. The teachers indicated that students built better interactions with their friends and teachers. The science club served as a meeting activity for some students and enjoying places for learning science without fear of being laughed by others and therefore, the science club provided sharing a common interest and curiosity between these diverse groups of students. Moreover, students developed a different positive perspective about their teachers during the field trips; they observed that their teachers made fun, laughed and made jokes. As a result of these contributions, students could develop an interest to science and emotional relations to the subject matter. Prokop and Zoldosova (2006) conducted an experimental study about field trips and they also focused on the affective variables in informal learning environments. The experimental group that included 153 participants experienced a 5-day long field trip to the Field Centre in Slovakia and the control group that included 365 participants who did not experience any field trip. There were two different methods in the study to determine students' interest in science. The first method investigated the pupils' interest by presenting them 45 fictitious book titles and 16 of them were related to field center courses and the other titles included other possible topics of interests. Pupils were expected to choose 5 topics out of 45. In the second method, researchers investigated students' ideas about science based on their drawings related to the ideal science learning environment. Results indicated that students in the experimental group chose the closer titles to the

field education, however, control group students generally chose popular topics which were not related to field education. Additionally, Field Center visitors drew more items related to field center environment. Lastly, researchers stated that field science education significantly contributed to students' motivation to learn science and their interest in science when compared with the formal school environment.

Konur, Sezen, Şeyihoğlu, and Tekbıyık (2011) made an action research on a summer science camp which had 48 7th grade students as participants in the study. The summer camp lasted five days and each day of the camp was allocated to one discipline as physics, biology, chemistry, geography, and learning through visits. Activities and visits included different types of experiments. Researchers gathered the data by using attitude towards science and technology course scale, attitude towards science scale, summer science camp evaluation survey, and interviews with students. They concluded that participants' attitudes towards science and science and technology course increased significantly and also summer camp had a role on increasing students' self-confidence related to science learning. Similarly, Bozkurt, İşeri, and Kırıkkaya (2011) examined the effect of the science summer camp. A total of 50 students who had passed to 6th grade participated in the camp. The camp lasted 5 days and activities and experiments were done throughout the whole day. Draw a Scientist Test (DAST) scale was used to gather the data and analyzed by content analyses of pre and post drawings. Results showed that students' perceptions of scientist changed positively. Their perceptions about sex and ages of scientists changed, their image of scientists became closer to reality.

Şentürk (2009) also studied the role of science centers on students' attitudes towards science. A total of 251 students from 6th to 8th grade visited METU Science Center (Ankara, Turkey) and their visit lasted one hour. The attitude scale was administered to the participants one week after the visit. Results of the study indicated that overall attitudes towards science of students changed positively after the METU Science Center visit. The researcher also indicated that when the students' science achievement scores increase, students' attitudes increase. Another research that indicated the relation between attitude and achievement in connection with the

informal learning environments was conducted by Whitesell (2016). The researcher used four data sources from thousands of students through six years which were administrative records from Urban Advantage Program, student-level administrative files, the New York State School Report Cards (SRCs), and the National Center for Education Statistics' Common Core of Data. The small positive effect was found at the end of the research and the researcher suggested to enriching educational experiences by using field trips could be beneficial for academic achievement scores of students.

Bozdoğan and Yalçın (2009) studied on educational usage of science centers in Ankara. Participants of the study are 31 directors, 50 elementary science education teachers and 349 students from 17 schools and they answered an email survey which includes open and close ended questions. The study showed that most of the students did not go to science centers and students who went to science centers did that with their schools. Therefore, the result of the study indicated the importance of integrating informal learning environments to the school curriculum in Turkey.

2.5. Empirical Studies on Informal Learning Environments in Teacher Education

National and international studies related to informal learning environments in teacher education are explained in this part of the study. Generally, studies in the literature are about the views of pre-service teachers about informal learning environments or enhancing pre-service teachers' knowledge, skills, or effects of integrating informal learning environments to formal teacher education programs.

Hsu (2016) made a phenomenographic study about science teaching experiences of pre-service teachers in Science Circus Days that were integrated into two science method courses throughout fifteen weeks (three-class hours per week). Science Circus Days were designed for providing the pre-service teachers to apply their lesson plans in an informal environment like a museum. There were two science circus days in the courses; the first one was in the middle and the second one was at

the end of the semester and by this way, the pre-service teachers had an opportunity for improving their second instruction considering their previous experiences. Science circus days took two hours. The pre-service teachers brought different materials such as posters or hands-on activities to draw attention of participants while applying their lecture. A total of 21 pre-service teachers attended to face to face interviews and additionally wrote their reflections for data gathering in the study. Data were analyzed by content analyses. Results of the study summarized the aspects of teacher education in informal environments; rapidly changing environments cause unpredictable situations in the learning process of informal environments and therefore, pre-service teachers learned that it is needed to extend researches for being more prepared while teaching in informal environments; informal learning environments provide interesting, rich sources to engage in science; diversity and free-choice environments causes challenges for pre-service teachers to keep visitors on task, they must obstacle with these challenges in the process of teaching; pre-service science teachers perceived themselves as contributing to science society; they can observe each other and share their experiences in the process of informal learning experience and this provides them a feedback to develop their teaching skills. As a result of these experiences; pre-service teachers enhance their self-confidence and could obstacle with the challenges in their professional life.

Other studies in the literature examine pre-service teachers' self-confidence with the content or teaching. For example, Jackson, Mohr-Schroeder, and Little (2014) conducted a mixed-method study to investigate the role of informal experiences on secondary STEM pre-service teachers with students who struggle with mathematics. A total of 32 participants attended a 15-week class. The pre-service teachers read the literature about struggling students on mathematics and teaching and assessment strategies to work with struggling students and they made discussions and role-plays in the first week of the class. Then, they went to middle or high schools once a week for one and a half hours in the after school informal environment format. Quantitative data sources obtained by using Teacher Self-Reflection Survey, Mathematics Clinic Tutor Survey, and a Student Survey. Qualitative data obtained by using semi-

structured interviews and written reflections. The pre-service teachers in the study had the opportunity of making real practices in real contexts. They indicated their self-confidence in the mathematical content increased. The pre-service teachers' ability to learn and apply research-based teaching strategies developed. Lastly, all of the pre-service teachers indicated the experience they got in the schools as the most beneficial aspect of their teacher education program. Another study, Atmaca (2012), focused on pre-service teachers' self-efficacy beliefs. She studied the effects of out of school environments on pre-service elementary science education teachers' self-efficacy by employing mixed-method research design. A total of 34 pre-service teachers registered to an elective course that included outdoor activities. They visited a zoo, a botanical garden, and a science center. The Self Efficacy in Science Teaching Scale, Pupil Control Ideology Scale, observation and interview forms were used to gather the data. The researcher conducted interviews with 9 of the pre-service teachers. Results of the study indicated there was a positive change in self-efficacy and pupil control ideology, however, it was not a significant change. Moreover, pre-service teachers increased their knowledge about informal environments and took it seriously after the activities. Additionally, the pre-service teachers stated the affective and permanent outcomes of informal learning environments. McLauglin (2015) also investigated the self-efficacy of pre-service teachers in a Saturday science program. A total of 26 pre-service teachers form the early childhood education program participated in the study. Saturday science program included 12 Saturday morning sessions and there were twenty to thirty students whose ages ranged between five and thirteen. Local families with their children were invited to the program and they had the opportunity of exploring different topics through various hands-on activities applied by the pre-service teachers. The Science Teaching Efficacy Beliefs Instrument was administered as pre- and post-test. In addition, semi-structured focus group discussions were used to gather the data. Results revealed that pre-service teachers' self-efficacy beliefs in inquiry skills, teaching in an informal context with diverse learners, and their knowledge of science content, materials, and procedures developed after the study.

In an effort to explore pre-service teachers' views about inquiry learning in informal environments, Glackin and Harrison (2018) conducted a study with pre-service secondary biology teachers. A total of 8 pre-service secondary biology teachers visited the Royal Botanical Gardens with their university tutors. Their visits included several inquiry-based activities throughout the day. After the visit, they attended the semi-structured interviews. Findings showed that the pre-service teachers' views about inquiry learning developed from simple notions to more sophisticated notions; they described botanical gardens as authentic science environments which provided memorable and autonomous learning by doing, asking questions, and developing curiosity.

Katz et al. (2010) also utilized inquiry activities to investigate professional identity development of teacher candidates who participated in an after-school internship program (HOSO-Hands-On Science Outreach) for elementary students. The program was designed as a three-year and yearly cycle divided into three sets of eight-week sessions that included Patterns, Energy and Structure and Challenge sub-themes. A total of 25 teacher candidates participated in the program in the spring session of Structure and Challenge topic. There were activities to enhance inquiry techniques like questioning, discussions, reflective times, material manipulations, process and pleasure of doing investigations. Data were gathered through interviews and drawings. Results indicated that at the end of the study, the professional identity development of teacher candidates improved. Teacher candidates observed themselves and had seen by others as science teachers. Additionally, Dai et al. (2013) made a case study about the role of informal science environment experiences on the development of two pre-service teachers' science classroom teaching identity. The teachers were in the second university year and an internship program (an after-school program for 3 months) the study was applied to them at the end of the second year before the science method course. There were adult leaders to guide the inquiry (questions, discussions, and reflective time), manipulation of materials, and ways in which to capitalize on student interest. As a result of the study, the participants indicated that informal learning environments were important for them since their

science classroom identities, excitement, and engagement in science teaching and quality of learning were developed. Adams and Gupta (2017) studied on teacher candidates for getting them to have a better understanding of diverse learners and enhancing teaching strategies by using rich sources of informal environments. A 15-month program that included two museums and two school activities was applied. There were three rotations in the study. Teacher candidates learned engaging visitors to make conversations related to movable carts about the objects in the exhibits in the first rotation; teacher candidates observed the interactions of master museum educators with middle and high school students who participated week and month-long museum programs in the second rotation; and teacher candidates had the opportunity to design and teach their lessons to high school students in the third rotation. Teacher candidates also took 'Applied Research in Science Learning in Informal Environments' course to learn the theoretical aspects of informal learning. Semi-structured interviews, online forum posts, surveys, and field notes were used to collect data from 36 pre-service teachers. Results of the study revealed that pre-service teachers felt as a part of a professional community and their future image of themselves as a teacher in the class improved. They developed reform-minded identities. They stated the importance of observing other teacher candidates' experiences for developing their career notions. They became more aware of the diverse learners. They decided to develop student-centered, minds-on, and hands-on activities in their future classes.

Çavuş, Kaplan, and Topsakal (2013) conducted a phenomenological study to determine the teachers' views about the activities in science houses. A total of 15 science and technology teachers who work in a Science House participated in the study. The teachers answered the semi-structured interview questions and open-ended questions. The results of the study showed that teachers emphasized the importance of informal learning environments for providing awareness about nature and linking informal education to formal education. Bozdoğan (2008) investigated 26 pre-service science teachers' views about teaching science in science centers. The pre-service teachers made a visit to Feza Gürsey Science Center in Ankara. After their visit, they

were interviewed and filled a science center evaluation scale. As a result of the study, many of the pre-service teachers indicated that they wanted to use these environments again since they were beneficial for developing themselves and useful for the learning of students. Providing permanent learning, abstracting the concrete topics, and increasing the interest of the students were the other topics stressed by the pre-service teachers. Bozdoğan (2012) also made an action research to explain the opinions and practices of pre-service science teachers in an elective course "Science Education in Informal Learning Environments." The study lasted two years and 34 last year pre-service science teachers participated in the study. The 12-week course included six different places for visits. Semi-structured interviews were performed at the first and last weeks of the course in addition to the observation forms to gather the data. The pre-service teachers' knowledge about using field trips for educational purposes and self-confidence to use these environments developed after the trips. At the first interviews, 21 pre-service teachers indicated that they would use informal environments for only entertainment, 7 of them for the purpose of education and 6 of them for both education and entertainment. After the visit, 24 of them stated using for both education and entertainment, 8 of them for education, 2 of them for only entertainment. Additionally, nearly all of the pre-service teachers believed themselves for organizing trips in the future. Regarding pre-service teachers' intentions to use informal environments, by using the Theory of Planned Behavior, Karademir and Erten (2013) examined whether pre-service teachers aimed to apply outdoor science activities in the science and technology course and what factors affected their aims. Outdoor Science Activities Performance Scale improved by Karademir (2013) was used to collect quantitative data from 1513 pre-service science teachers and qualitative data were collected through structured interviews with 26 participants. One of the important highlights of the study was an increase in the self-efficacy of pre-service teachers. The pre-service teachers indicated that with the help of informal learning experiences, students develop their social skills; permanent and effective learning can occur and students' curiosity increases; therefore, it is needed to use them in science learning. Kisiel (2013) made a study to investigate pre-service teachers' views about

science out of the school in an elementary science teaching method course that included workshops, field trips, and family day activities in local informal environments throughout a semester. The course lasted 15 weeks. The pre-service teachers answered the pre-semester (n = 191) and post semester (n = 168) surveys about informal learning environments. They expressed how informal environments helped them as a new science teacher: providing resources; supporting teacher education; developing the quality of science instruction; and providing student learning, community connections, and hands-on experiences.

CHAPTER 3

METHODOLOGY

This chapter is designed to describe the method of the study. The design of the study, research questions of the study, participants and context of the study, data collection instruments and procedure, data analysis, validity and reliability issues of the study, limitations of the study and assumptions of the study will be introduced, respectively.

3.1. Design of the Study

The purpose of this study was to investigate the views of pre-service science teachers about informal learning environments before and after visiting the Science and Technology Museum in METU. This research was designed as a qualitative research to determine what the pre-service science teachers' views about informal learning environments were and the changes in their views after a trip to the Science and Technology Museum in conjunction with Methods of Teaching Sciences I Course in the fall semester of 2018-2019.

Although quantitative research focuses on numbers and answers the questions related to how many, how much, and cause and effect relations of subjects, qualitative research is based on the meaning of a phenomenon, interpretation, and construction of experiences, feelings, and ideas of people (Merriam, 2009). Creswell (2007) stated the characteristics of qualitative research as: Data source is in the natural setting; researcher collects the data with the close interaction and therefore, researcher is the key instrument for the data collection; data will be analyzed inductively; perspectives and views of participants will be focused; emergent design of human behavior and

belief is constructed in its social, political, historical or cultural context; role of the researcher, reader, and participants are reflected in the study.

This study is designed as a basic qualitative research. Basic qualitative research is interested in the interpretation of experiences, construction of worlds, and how people put on meanings to their experiences (Merriam, 2009). All of these characteristics are included by other qualitative studies such as case study, phenomenological, grounded theory study, ethnography, narrative analyses, and critical qualitative research, however, other types have an additional characteristic, to illustrate; if analyses are based on a case in the study, this study can be defined as a case study; a phenomenological study tries to understand the core and the causes of a phenomenon; ethnography tries to understand interaction of individuals in their sociocultural contexts; grounded theory study tries to understand a phenomenon of interest and also constructs a substantive theory about it; narrative analyses use and analyze the stories of people to understand the meanings of experiences in the story; and critical qualitative researches make social critiques to provide people being more aware of problems (Merriam, 2009). Patton (2015) also described the purpose of basic research as contributing to fundamental knowledge and theory. Because the aim of this study is investigating how pre-service science teachers interpret their experiences and what the meanings that pre-service science teachers attribute to their experiences about informal learning environments are before and after the science museum visit, basic qualitative research design fits the purpose in the study. Moreover, the results of the study can contribute fundamental knowledge about informal learning environments.

3.2. Research Question

The research question of this study is:

What are the views of the pre-service science teachers about informal learning environments before and after visiting the Science and Technology

Museum in METU in conjunction with the Methods of Teaching Sciences I course?

3.3. Participants and Context of the Study

In this study, purposeful sampling was used to select the participants. Purposeful sampling means selecting information-rich cases which provide in-depth understanding of the issues (Patton, 2015). “Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned” (Merriam, 2009, p.77).

The purpose of that study was to investigate views of pre-service science teachers about informal learning environments before and after visiting a science museum and therefore, it is needed to select participants who are involved in a science museum visit activity. As a result, a total of 17 pre-service science teachers who have been taking the course of Methods of Teaching Sciences I during the 2018-2019 fall semester at the Faculty of Education in a public university in Ankara participated in the study. There were 30 students who were registered to the course and 23 of them accepted to volunteer for the interviews, however; 6 pre-service science teachers gave up attending the research during the interviewing process. All of the pre-service science teachers were in their third year in the university. There were only two male pre-service science teachers among the participants. Of participants, five pre-service teachers indicated that they did not have any experience in informal learning environments. The others had some experiences: While nine pre-service science teachers mentioned that they had experiences related to family, internet, readings, hobby courses, library, and seminars, only four pre-service science teachers stated that they had experiences in the museums and science centers.

An elementary science teacher education program at a public university in Ankara constituted the context for this study. This four-year program certifies undergraduates as science teachers for grades 5-8. During their four-year program, science education

majors take science courses (e.g., general chemistry, physics, biology), general pedagogical courses (e.g., educational philosophy, instructional planning and evaluation), subject-specific pedagogical courses (e.g., methods of science teaching, laboratory experiments in science education), and elective science education courses (e.g., history of science, environmental education). Method of Teaching Sciences I is a must course in the program and takes four hours per week. Concepts of science process skills, scientific inquiry, nature of science, conceptual understanding, graphical organizers, such as concept map, V-diagram, KWHL, and roundhouse, and teaching strategies and their applications in elementary science education and analysis of science textbooks are in the focus of course. This must course also includes a section which pre-service science teachers are informed about informal learning environments through a week and students taking the course make a visit to the Science and Technology Museum in METU after the information about informal learning environments. The pre-service science teachers did not take any course about informal learning environments before that lecture.

3.3.1. Setting of the Science and Technology Museum in METU

Science and Technology Museum in METU was built in 2006 with the purpose of making science fun and understandable. It serves students especially from middle schools but students from primary schools and high school could visit the museum with personally, with their family or teachers. Teachers could bring their students to the museum as a part of their science class.

There are two researchers who have responsibility for developing the activities in the museum, coordinating the visits and counseling the visitors. There are approximately seventy devices that provide interactive opportunities to visitors. These devices are generally related to mechanic, electric, magnetism, light and optics, sound and waves, perception, environment, mathematic and intelligence. Visitors in the museum can select the devices that they want to use and they can interact with the

devices by reading the directions in the written explanations related to devices or they can get help when they need. Exhibition set up catalog is accessible in the website of the museum (http://bit.ly/sergikatalogu). The detailed information about the devices and activities can be obtained from this website.

Some examples of the devices: Human Circulatory System device provides students with an understanding of the systematic circulation and microcirculation and internal structure of the heart. Age-rings in Trees provides to see how scientists calculate the ages of trees by using the rings. Carbon Footprint device is related to counting carbon release of humans according to their daily life activities and give advices to decrease the carbon footprint. Van de Graaf Generator enables to examine static electricity. Spinning Wheel and Pulley Systems help students understand the working principle of these systems. Gravity simulation provides students with an understanding the relation between mass and gravity and measuring gravity in the different celestial bodies. Bell in the Vacuum is for understanding the requirements for spread of the voice. Different types of mirrors enable students to explore occurrence of images in mirrors. Galton Box is related to the concept of the probability. Puzzle and tangram aim to develop memory.

The pre-service science teachers in the study examined and tried to use many of the devices. However, they generally worked on the devices related to biology and physics such as Carbon Footprint and Gravity Simulation. They formed small groups that included 2-3 persons and worked on the activities as a group. I observed that they generally had difficulty on working with the puzzles and tangrams and they did not want to spend much time on these activities.

3.4. Data Collection Instrument and Procedure

Data of the study were collected through interviews. Interviews allow researchers to understand the perspective of the other person; researchers can get what is in someone else's mind by interviewing (Patton, 2015). Interviewing is needed

when we could not observe the behavior and feelings of participants and it is also necessary for understanding how people interpret their experiences (Merriam, 2009). There are types of interview techniques; highly structured, semi-structured, and unstructured interviews. In the present study, semi-structured interviews were utilized because they are between highly structured and unstructured interviews and they include more flexibly worded questions than highly structured interviews and more stably worded questions than unstructured interviews (Merriam, 2009). Moreover, semi-structured interviews include a list of questions or some issues to be explored, however; there is no need to exact wording or order in the questions, in other words, researcher add or remove questions through the interview and therefore, semi-structured interviews provide researcher to get directly the actual ideas and worldview of the respondent and also to obtain new ideas related to the topic (Merriam, 2009).

Questions in the interviews were designed to get broad information from pre-service science teachers about informal learning environments. Merriam (2009) mentioned that:

> The key to getting good data from interviewing is to ask good questions; asking good questions takes practice. Pilot interviews are crucial for trying out your questions. Not only do you get some practice in interviewing, but you also quickly learn which questions are confusing and need rewording, which questions yield useless data, and which questions, suggested by your respondents, you should have thought to include in the first place. (p. 95)

Considering all of this information, two semi-structured interviews were conducted to reveal the views of the pre-service science teachers about informal learning environments before and after the science museum trip and to explain the changes in their views, if there was. The first interview included 12 questions and lasted about 20 minutes and the second interview contained 18 questions and lasted about 30 minutes.

Interview questions were constructed considering the aim of the study and related literature (Atmaca, 2012; Bozdoğan 2008; Bozdoğan & Yalçın, 2009; Fenichel & Schweingruber, 2010; Kisiel, 2014). An expert from chemistry education examined

the questions to ensure that the questions were clear, not leading and confusing, and were appropriate for the purpose of the study. A pilot interview was done with three pre-service science teachers in their second year at the Faculty of Education in the university. These pre-service teachers did not participate in the study and they did not have any interaction with the participants of the study. They did not have any experience in informal learning environments and did not take any course about informal learning environments. Interview questions were generally understandable for the pre-service science teachers, however; the pilot study provided revise and refine for some of the questions. The pre-service science teachers in the pilot study were asked whether they have been educated in such an environment so far, however, they did not mention their experience in detail, therefore, this question was revised by adding that "If so, would you share your thoughts on this experience?" Then, the interview questions were put into the final form (see Appendix A). The first interview was conducted before the lecture about field trips and the visit to the Science and Technology Museum. The second interview was performed after visiting the Science and Technology Museum. The second interview included the questions in the first interview and also other questions related to the science museum trip.

Sample interview questions from the first interview are:

- What do you think about informal learning environments and what do you know about these environments?
- Have you been educated in such an environment during your student years so far?
- Why and how do you use out-of-school learning environments as teachers?

Sample interview questions from the second interview are:

- What are the things you interpret as good about the museum trip? Why?
- What did you like most about the trip (activity, mechanism, etc.)? Why?
- Would you take your students on such a trip? Why?

The pre-service science teachers were given information about field trips for two hours in the Methods of Teaching Sciences I course. Then, they went to the Science and Technology Museum in the next week with their instructor. I observed the pre-service science teachers in the museum. The pre-service science teachers

attended to a seminar in the museum at the beginning of the visit. One of the counselors in the museum shared their experiences and observations about field trips. She mentioned how teachers could use field trips in an efficient way. She did an activity about the current of electricity at the end of the seminar to attract the attention of the pre-service science teachers. She used a ping pong ball which included an electrical circuit in it. There must be conductors for electrical current. She used some of the pre-service science teachers as conductors. The counselor and one the pre-service science teacher touched the ball and all of them held each other's hands. As a result, they turned the light on in the ball. After the activity, the pre-service science teachers had the leisure time to observe and to deal with the devices in the museum. The counselor and instructor helped them when they needed or when they had a problem. Meanwhile, I observed the pre-service science teachers through that leisure time.

3.5. Data Analysis

"Content analysis is the data analyses technique of that research and refers to searching text for and counting recurring words or themes" (Patton, 2015, p. 541). Coding is a part of content analysis method and can be defined as abbreviating the transcribed text into single words, letters, numbers, phrases, colors or combination of these to capture some specific parts of the data and by this way researcher could construct categories or themes by grouping the codes which could be put into the same category after coding the whole transcribed text (Merriam, 2009). Creswell (2007) also stated that analyzing data in qualitative research includes these steps: First of all, data must be prepared and organized (e.g. text data in transcripts), then data must be reduced into themes by coding, after that codes will be condensed and finally data will be represented in figures, tables or a discussion.

Considering all of the above information, the researcher transcribed the interviews into text form and then whole text is coded, after that themes were constructed and a coding protocol table (Table 3.1) was formed which included

themes, sub-themes and sub-sub-themes, and examples which were quoted from the interviews of pre-service science teachers. All of the interviews were coded again according to the coding protocol table. After that, results were constructed by counting sub-sub-themes according to content analysis method and they were represented as frequencies in the tables. Frequency tables shown in Chapter IV are the representations of the analyses in the research.

Table 3.1. *Coding Protocol*

Themes & Sub-themes	Explanations & Sub-sub-themes	Examples
Venues of informal learning environments	It defines places where informal learning takes place.	
• everyday environments	places in which one uses the internet, reads books, newspapers, articles or journals, or develops hobbies	"Internet, library, science journals, articles are can be thought as informal learning environments"
• designed environments	library, museums, science centers, zoos, aquariums, observatories, parks	"Everywhere that promote learning in the out of school could be defined as informal learning environments such as museums, libraries, natural environments, observatories, aquariums, zoos."
• programs	seminars, conferences, science clubs, and after school activities	"Seminars are very effective to learn science for example I attended to the seminars of Foundation of Brain in METU. It was beneficial for me."
Significance & benefits of informal learning environments	It defines the important and beneficial properties of informal learning environments according to the pre-service science teachers.	
• affective variables	It defines feelings and beliefs of pre-service science teachers related to informal learning environments such as enjoyment, interest and curiosity, self-confidence, motivation, liking, attention, decrease in anxiety, breakdown of prejudices, awareness to nature	"If we take away the students to an observatory, their motivation increases with the magnificence of the planets, teacher could encourage the students to learn the topic. They try to do research and learn by themselves and they become more curious."
• learning of students	It defines thoughts of pre-service science teachers related to learning of students in the informal learning environments and includes sub-sub-themes as effective learning, science process skills, and psychomotor skills	"Informal learning environments are useful for providing prior knowledge to students before teaching the concepts in the class or reinforcing the subject after teaching in the class."

• learning environment	It defines thoughts of pre-service science teachers about properties of informal learning environments and includes sub-sub-themes as social interactions, different age groups, volunteering, little rules, no grading, more applications, opportunity to do wrong and to try again, no time limitation, active student, relaxing environment.	"Communicating with each other or counselors can develop social skills of students. Their communication skills increase."
Disadvantages of informal learning environments	It defines negative ways and problems related to informal learning environments.	
• instructional difficulties	It defines views of pre-service teachers about difficulties related to instruction in informal learning environments and includes sub-sub-themes as unplanned trips, discipline problems, misconceptions, only enjoying entertainment, extra labor, curriculum-time constraint, dislike to school, insufficiency of the teacher, safety, examination system.	"There can be a chaos if teacher go to informal learning environments with crowded groups. It is difficult for one teacher to control and counsel the students, therefore, there must be at least two teachers according to the number of students in the trip. Teacher must be prepared about trip to provide effectiveness."
• lack of inspection	It defines insufficiency about controlling the private informal learning environment institutions by the authorities.	"There must be inspections on the places such as hobby courses or workshops. It is dangerous to give permission everyone to open such places."
• financial problems	It defines the insufficiency of financial supports to using informal learning environments in instruction.	"Financial problems are important disadvantages to use informal education in learning. Students could not have equal opportunities to provide financial support. For example, I attended a project of Scientific and Technological Research Council of Turkey (TUBITAK) and it was not possible for me to cover costs as my own. Accommodation and transportation costs are too high."
• transportation problems	It defines difficulties related to moving students from formal classes to informal learning environments.	"It is difficult to the students to move from one place to the another"

• bureaucratic procedures	It defines legal permissions needed to move students to informal learning environments.	"It is difficult to take needed permissions for going informal learning environments with students especially in public schools."
Using informal learning environments in future as a teacher	It defines ideas of pre-service science teachers related to using informal learning environments in their instruction in the future.	
• learning of students	Learning of students is a cause of using informal learning environments in the future as a teacher and it includes sub-sub-themes as effective learning, effective instruction.	"I want to use informal learning environments since they are appropriate for teaching science. They provide many opportunities and applications to promote effective learning."
• developing positive attitudes	Developing positive attitudes such as interest, motivation, curiosity, awareness, and enjoyment is a cause for using informal learning environments in the future.	"I use informal learning environments in future since it is a good way for arousing interests of students."
Assessment of learning in informal learning environments	It defines thoughts of pre-service science teachers about how to assess learning in informal learning environments.	
• type of assessment	worksheets, student views, discussion, quizzes, writings, drawings, KWL questions, presentations, project, observing students' skills	"I can evaluate the students only by observing. There will be many students, therefore; it is difficult to make grading them."
• time of assessment	during, after	"I can give worksheets before going to trip and I can ask them to fill the questions during the visits. By this way, I can be sure about that they try to understand the activity in the trip."
Science and Technology Museum Trip	It defines positive and negative sides of the Science and Technology Museum and ideas of pre-service science teachers after the visit.	
• positive sides	It defines pre-service science teachers' favorite and most useful things in the museum such as devices, seminars, activity, written explanations about devices, counselors in the	"I liked devices since they are colorful and funny. We used the devices ourselves and our self-confidence increased. This was an unusual experience and there was opportunity to see the reality of what we learned."

	museum, experience, opportunity to try all things.	
• negative sides	It defines problems in the museum according to pre-service science teachers such as repetition of the lesson, devices that do not work, insufficient devices, location of the museum, architecture of the museum, not appropriate to PSTs' levels, long or insufficient written explanations, date of the trip, no meetings with students.	"I don't see the museum adequate. Some materials are always damaged and they remain corrupted for a long time. Written explanations are insufficient. Students should be guided to read the descriptions by counselors. Silence must be provided to understand what we read."
• ideas after the Science and Technology Museum trip	Preservice science teachers mentioned after the visit that they learned more about how to define, how to apply, how to use in the future, how to integrate into the curriculum.	"I mentioned the online platforms as informal learning environments before the visit. I learned the field trips after the visit. That is useful for me. I saw the alternatives to use as informal learning environments."

There are six main themes in the coding table: Venues of informal learning environments, significance, and benefits of informal learning environments, disadvantages of informal learning environments, using informal learning environments in the future as a teacher, assessment of learning in informal learning environments and the Science and Technology Museum trip. Sub-Themes of venues of informal learning environments were constructed according to the National Research Council report (2009) as everyday informal environments, designed environments, and programs (as cited in Fenichel & Schweingruber, 2010).

Significance and benefits of informal learning environments theme includes three sub-themes according to the answers of pre-service science teachers which are affective variables, learning of students and learning environments. Affective variables are the beliefs and feelings of pre-service science teachers related to informal learning environments such as enjoyment means "the meeting and fulfillment of a person's needs" (Lin & Gregor, 2006, p.5), "interest and curiosity mean a student who is interested or curious about a science topic has a readiness to pursue it" (Koballa & Glynn, 2007, p.88), "self-confidence means a person's perceived capability to accomplish a certain level of performance" (Bjork & Druckman, 1994, p.174) "Motivation is an internal state that arouses, directs, and sustains students' behavior" (Koballa & Glynn, 2007, p.85), liking is the positive feelings and pleasure about learning science, attention is the thoughts and actions of people could be focused on only some aspects of the environment related to internal goals and external factors (Harrison & Lodge, 2019, p.24), "anxiety means an unpleasant emotional arousal in response to situations that are perceived as threatening" (Koballa & Glynn, 2007, p.88), breakdown of prejudices means changing the bias or negative attitude toward learning science and lastly awareness to nature means becoming more knowledgeable and careful about the nature. Learning of students' sub-theme defines thoughts of preservice science teachers about learning of students in the informal learning environments. Effective learning, science process skills, and psychomotor skills were constructed as sub-sub-theme according to answers of preservice science teachers. "Effective learning is constructing an activity in the best way and includes meta-

cognitive processes of planning, monitoring and reflecting" (Watkins et al., 2002, p.5) and effective learning in the study includes terms such as learning by seeing and trying, better learning, comprehensive learning, meaningful learning, inductive learning, learning in a short time, retention, reinforcement, concretization, providing prior knowledge, using real-life examples, visuality, continuous learning, using different senses, and being against to rote learning. Science process skills are transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists such as observing, inferring, measuring, communicating, classifying, predicting, etc. (Padilla,1990). Science process skills in the study include terms such as observation, creativity, thinking, imagination, and problem solving. Psychomotor skills are muscular activities and sensorimotor skills that occur as a reflect to signals from the environment (Cratty & Noble, 2019). Pre-service science teachers mentioned the learning environments also as significant and mentioned the benefits of informal learning environments. They stated some properties about informal learning environments and these properties were constructed as sub-sub-themes: social interactions in the informal learning environments, different age groups with different backgrounds, volunteering to attend activities in the informal learning environments, little rules to guide participants, any grading system, more applications, and these applications provide opportunity to do wrong and to try again, there is no time limitation about learning the subjects, students are active participants of learning process in the informal learning environments and there is a relaxing environment that means participants are not stressful and there is no cause for anxiety.

Disadvantages of informal learning environments in Table 3.1 refer some negativities and problems in informal learning environments such as instructional difficulties, lack of inspection, transportation problems, financial problems, and bureaucratic procedures. Difficulties related to instruction such as unplanned trips, discipline problems, misconceptions, only enjoying entertainment, extra labor, curriculum-time constraint, dislike to school, insufficiency of the teacher, safety, examination system are constructed as sub-sub-theme of instructional difficulties in Table 3.1. Lack of inspection refers the need for controlling private informal learning

environments. Transportation problems state difficulties about moving the students from formal classes to informal learning environments and financial problems mention the difficulties about money and sponsor and lastly bureaucratic procedures mention difficulties related to taking needed permissions to go to informal learning environments.

Pre-service science teachers want to use informal learning environments in the future as a teacher related to the learning of students and developing positive attitudes in the students as seen in Table 3.1. Effective learning and effective instruction are constructed as sub-sub-themes and informal learning environments make contributions to better learning of students and teachers can provide more opportunities to design effective instruction in the informal learning environments

Assessment of learning in informal learning environments includes two items in the coding protocol table (Table 3.1) which are the type of assessment and the time of assessment. Pre-service science teachers mentioned worksheets, student views, discussion, quizzes, writings, drawings, KWL (What do you know?-What do you want to know?-What did you learn?) questions, presentations, projects and observing students' skills as assessment techniques in the informal learning environments and making assessment during the visits or after the visits were stated.

Positive sides, negative sides, and ideas after the Science and Technology Museum trip were stated as sub-theme of the Science and Technology Museum Trip theme in Table 3.1. The favorite and the most useful things in the museum such as devices, seminar, activity, written explanations about devices, counselors in the museum, experience, opportunity to try all things were positive sides of the trip according to pre-service science teachers and they mentioned some negative sides such as repetition of the lesson, devices that do not work, insufficient devices, location of the museum, architecture of the museum, not appropriate to PSTs' levels, long or insufficient written explanations, date of the trip, no meetings with students in the trip. Additionally, pre-service science teachers mentioned that they learned more about how to define the venues of informal learning environments, how to apply trips in

such environments, how to use informal learning environments in the future, and how to integrate them into the curriculum.

3.6. Validity and Reliability Issues of the Study

Validity and reliability are important aspects for all types of research and they can be provided with careful attention through the processes of the conceptualization of the study, collection, analyses, and interpretation of the data, and also presentations of the findings. There are several strategies to constitute the authenticity and trustworthiness of a qualitative research; credibility, transferability, and dependability terms are replaced with internal validity, external validity, and reliability, respectively, which are used in quantitative research (Merriam, 2009).

3.6.1. Credibility

If the findings of the study could match with the reality, credibility could be provided in the study (Merriam, 2009). Interpretations of the reality in qualitative research depend on humans as a primary source of data collection and analyses process, therefore; reality can be obtained by exploring the perspectives of individuals related to study, revealing the complexity of the human behavior in the context and presenting the whole process of the study in detail (Merriam, 2009). Triangulation, member check, adequate engagement in data collection, researcher's position, and peer debriefing are the strategies to provide credibility in qualitative research (Merriam, 2009). In the present study, investigator triangulation, adequate engagement in the data collection, researchers' position and peer debriefing are utilized to ensure the credibility.

Investigator triangulation means having two or more persons to analyze the data independently and reviewing and comparing the findings (Merriam, 2009; Patton, 2015). Another analyst reads the transcribed text of the interviews in the study. Codes

are generated through a discussion process. In the present study, first, I and another researcher who had experience in qualitative research read three of the transcripts independently and suggested themes and sub-themes. Then, researchers came together and compared their themes. As a result of the discussion, they reached consensus on the themes and finalized the coding process. Adequate engagement in data collection occurs if a researcher tries to get close to a participant's understanding of phenomenon (Merriam, 2009). In this study, I tried to meet with the participants before the first interview to have close interaction with participants and then, I observed pre-service science teachers' classes about the field trip. Additionally, I attended to the Science and Technology Museum trip and I observed the pre-service science teachers throughout the trip before the second interview.

Researcher is needed to explain his/her position, biases, assumptions and theoretical orientation in the study since this clarification provides readers to understand in what conditions researcher interprets the data of the study (Merriam, 2009).

Peer debriefing technique was used according to the natural process of the construction of the study with comments of the supervisor through all of the processes and comments of the thesis committee.

3.6.2. Dependability

In quantitative research, reliability is an assumption about the reality of the study and refers that performing the research repeatedly will result with the same findings; however, this is not possible for qualitative research due to its nature. People and their behaviors and ideas change continuously, therefore; consistency of the results with the data of the study is the important point of the dependability in qualitative research (Merriam, 2009). Triangulation and audit trails are the strategies for ensuring the dependability in that research (Merriam, 2009). "Triangulation, for example, can be seen as a strategy for obtaining consistent and dependable data, as

well as data that are most congruent with reality as understood by the participants" (Merriam, 2009, p.222). Audit trail is describing collection of the data, derivation of the categories and making of the decisions in detail throughout the inquiry and dependability of the study can be provided by this way since there will be enough explanations about how the results were arrived in the study (Merriam, 2009).

Additionally, the formula of intercoder reliability of Miles & Huberman (1994) was used to ensure dependability.

Reliability = Number of agreements / (Total number of agreements + disagreements)

The inconsistencies between coders were resolved through discussions. Intercoder reliability was found to be .89 which was acceptable (Miles & Huberman, 1994).

3.6.3. Transferability

Transferability means according to Lincoln and Guba (1985), that the degree to which findings of a study are useful for other similar research (as cited in Merriam, 2009). Transferability can be ensured through "highly descriptive, detailed presentation of the setting and the findings of a study by presenting adequate evidence in the form of quotes from participant interview" (Merriam, 2009, p. 227). In other words, according to Lincoln and Guba (1985) the investigator needs to provide "sufficient descriptive data" to make transferability possible (as cited in Merriam, 2009). As a result, thick description is necessary to ensure transferability. In the current study, I explained the context of the study where the study was conducted in detail; I provided information for the teacher education program the pre-service teachers followed, the prerequisite courses the pre-service teachers had taken so far, the content of the Method of Teaching Sciences I course, and the devices and activities in the Science and Technology Museum.

3.7. The Role of the Researcher

Role of the researcher must be stated to provide credibility in the study since researcher is the key instrument of the research (Merriam, 2019). I was in the role of an observer in the study. I observed the pre-service science teachers in the lecture and in the museum. However, I did not interfere with anything through the observations and I did not use the observations as a data collection tool. I observed the pre-service science teachers to see the learning environments in the class and in the museum. I observed their interactions with each other, instructor and consultant in the museum.

3.8. Ethical Issues

Ethical issues checklist that is constructed by Patton (2002, p. 408) includes these items; "explaining purpose, promises and reciprocity, risk assessment, confidentiality, informed consent, data access and ownership, interviewer mental health, advice, data collection boundaries, ethical versus legal".

I applied to Human Subjects Ethics Committee (HSEC) permission in the Middle East Technical University and permission was taken at the beginning of the study. General information about the study was explained to the participants. It was announced that there was not any risk or harms for the participants in the study. Anonymous names were used to indicate the pre-service science teachers as PST. Also, anybody did not have any access to the data except for the researcher and the supervisor. The researcher explained to the participants that they could drop the interviews whenever they would want.

3.9. Limitations of the Study

There are mainly two limitations in the study. Firstly, there were limited number of participants depending upon the number of pre-service science teachers registered to the Method of Teaching Sciences I Course. Secondly, Science and Technology Museum in METU was used only for three hours. Pre-service science

teachers could spend more time in the museum or other informal learning settings to have more knowledge about informal learning environments.

3.10. Assumptions of the Study

Participants of the study are assumed as information-rich and it is assumed that they answered the interview questions honestly and sincerely.

CHAPTER 4

RESULTS

In this chapter, the results of the study are presented to explain the views of the pre-service science teachers about informal learning environments before and after visiting the Science and Technology Museum in METU as a part of Methods of Teaching Sciences I course. Results are displayed based on the themes generated through the examination of the pre-service teachers' answers to the interview questions and are supported by examples. Anonymous names such as PST1, PST 2, etc. are used for the pre-service teachers in the study while giving examples from the interviews throughout the results part.

As explained in Chapter 3 - Methodology part, totally, six themes were constructed by analyzing the data: venues of informal learning environments, significance and benefits of informal learning environments, disadvantages of informal learning environments, using informal learning environments in future as a teacher, assessment of learning in informal learning environments, and the Science and Technology Museum trip. The definitions and samples of these themes are presented in Table 3.1. The coding protocol table in Chapter 3. Table 4.1 includes all six themes and their total frequencies which show how many pre-service science teachers talked about these themes before and after the science museum visit. As seen in Table 4.1, the frequencies of the themes increased after the Science and Technology Museum trip. It is seen that the knowledge of the pre-service science teachers about science museums developed since they stated more comprehensive definitions about informal learning environments; they considered more aspects while describing venues of informal learning environments after the science museum visit. In addition, they mentioned more about significances and benefits of such environments.

Moreover, the frequency of the aspects they stated for applications and advantages of informal learning environments went up; they became more conscious about applications, advantages, and usage as well as disadvantages of informal learning environments. In the following parts, the pre-service science teachers' answers under each theme are explained in detail.

Table 4.1. *Total Frequencies of the Themes*

Themes	Frequencies Before the Visit	Frequencies After the Visit
Venues of informal learning environments	37	59
Significance and benefits of informal learning environments	115	155
Disadvantages of informal learning environments	28	62
Using informal learning environments in future as a teacher	26	42
Assessment of learning in informal learning environments	29	41
The Science and Technology Museum Trip	-	72

4.1. Venues of Informal Learning Environments

Venues of informal learning environments theme are emerged from the answers of the pre-service science teachers to the question about the definitions of informal learning environments. Analyses of the pre-service teachers' answers revealed that before visiting the Science and Technology Museum, pre-service teachers emphasized everyday informal learning environments as places where they use the internet, read books, newspapers, articles, and journals, and develop a hobby. However, after visiting the Science and Technology Museum, pre-service science teachers' ideas shifted to designed environments such as library, museums, science

centers, zoos, aquariums, observatories, parks, and programs such as seminars, conferences, science clubs, and after school activities (e.g. visiting waste treatment plants and natural environments).

Table 4.2 demonstrates the change in the pre-service science teachers' ideas about venues of informal learning environments before and after the Science and Technology Museum visit. As seen in Table 4.2, the frequencies related to designed environments such as museums and science centers increased after visiting the Science and Technology Museum. The pre-service teachers did not include private teaching institutions as informal learning environments because they were similar to formal classroom environments and teachers in those institutions are likely to use the lecture method as in formal education. Although some of the pre-service teachers stated them as informal learning environments, the frequency of private teaching institutions decreased after pre-service teachers' visit to the Science and Technology Museum.

Table 4.2. *Frequencies for the Venues of Informal Learning Environments*

Venues	Frequencies Before the Visit	Frequencies After the Visit
everyday environments	18	4
designed environments	13	39
programs	6	16
total frequency	37	59
private teaching institutions	6	3

Venues of informal learning environments stated by the pre-service science teachers are places they use the internet (YouTube particularly), do research such as library, read books, articles, and journals, as well as hobby courses, seminars and conferences, family and friend conversations, and museums, science centers, science workshops, zoos, aquariums, water treatment plants, natural environments,

observatories, parks, and science clubs. The frequencies of these venues are displayed in Table 4.3.

Table 4.3. *Frequencies for the Contents of the Venues*

Venues	Frequencies Before the Visit	Frequencies After the Visit
private teaching institutions	6	3
internet	5	
library	4	2
reading	3	-
hobby courses	4	1
seminars/conferences	4	1
family, friend conversations	6	3
museums	4	17
science centers	3	11
science workshops	1	4
zoos	1	3
aquariums	1	1
waste treatment plants	-	1
natural environments, ecology	1	8
observatories	-	1
parks	-	4
science clubs	-	2

To exemplify, one of the pre-service science teachers, PST3, indicated hobby courses as an informal learning environment before visiting the Science and Technology Museum but then she added the museums to her statements. Additionally, although PST5 stated the internet, library, reading journals and articles before the museum visit, her ideas changed to museums, science centers, natural environments, observatories, aquariums, and zoos afterward. PST4 also described only private teaching institutions as an informal learning environment before and her answer turned to museums, waste treatment plants, and other natural places after visiting the Science and Technology Museum. As a result, pre-service teachers' views about venues for informal education became more detailed after science museum visit.

4.2. Significance and Benefits of Informal Learning Environments

This theme reflects how pre-service science teachers perceive the significance and benefits of informal learning environments. As a result of analyses of the pre-service science teachers' answers to the interview questions, three sub-themes were constructed: affective variables, learning of students, and learning environments.

4.2.1. Affective variables

This sub-theme is obtained by coding the affective terms such as enjoyment and interest in the answers of the pre-service science teachers related to informal learning environments. The frequencies of the affective variables increased nearly two times after visiting the Science and Technology Museum. While the pre-service teachers stated about affective variables 27 times before the science museum visit, they mentioned these variables 53 times after the visit.

Table 4.4 presents the frequencies of affective variables stated by the pre-service teachers. Enjoyment, interest and curiosity, and motivation are the most frequently stated affective variables by the pre-service science teachers, especially

after the Science and Technology Museum visit. To illustrate; before the visit, PST9 said that "Students could listen to the topics more carefully in informal learning environments since they are active in the learning process" and after the visit, she mentioned enjoyment and interest and said that "Students consider learning as a game in the informal learning environments. Therefore, they enjoy learning and they become more interested in the courses." Additionally, PST10 did not say anything about the affective variables before, however, after the visit she stated enjoyment and interest likewise PST9 and said that "Students' interests in the courses increase in informal learning environments. They get bored in school environments but because of being active in the informal learning environments, they have fun and effective learning occurs." PST6 also did not mention affective variables before the visit but after the visit she expressed motivation as "If we take away the students to an observatory, their motivation increases with the magnificence of the planets, teachers could encourage the students to learn the topic. They try to do research and learn by themselves and they become more curious."

Self-confidence, liking, attention, decrease in anxiety, breakdown of prejudices, and awareness to nature are the other affective variables stated by the pre-service science teachers. To articulate; before the visit, PST7 talked about self-confidence and stated that "I could be more self-confident in informal learning environments because of social interactions with many people." After the visit, she mentioned the attention as "It is difficult to draw attention of students in a crowded classroom environment but places like museums could draw the attention of students in a matter of minutes by using different visuals and interesting things. Even though there is only one student who draws his/her attention to the topic or likes the course, this is an important outcome for a teacher." PST1 did not say anything about breakdown of prejudices before the visit, however, after the visit she mentioned that "There are many activities to broaden students' horizon about physics, chemistry, and biology, etc. and they enable students to eliminate their bias regarding science since they do not need to memorize the subjects as in the class." Moreover, PST8 did not have any idea about the affective variables related to informal learning environments

before the visit, while after the visit she said that "Using natural environments such as Eymir Lake in teaching science provides students with awareness to the nature and living creatures. Students could be more sensitive to the environment."

Table 4.4. *Frequencies of Affective Variables*

Affective variables	Frequencies Before the Visit	Frequencies After the Visit
enjoyment	11	18
interest & curiosity	5	16
self- confidence	2	1
motivation	5	6
liking	2	4
attention	1	3
decrease in anxiety	-	1
breakdown of prejudices	1	1
awareness to nature	-	2

4.2.2. Learning of students

This sub-theme is constructed by coding the answers of pre-service science teachers related to learning of students in informal learning environments. Results of the analyses are grouped as effective learning, science process skills, and psychomotor skills under learning of students' sub-theme. Effective learning includes terms such as learning by seeing and trying, better learning, comprehensive learning, meaningful learning, inductive learning, learning in a short time, retention, reinforcement, concretization, providing prior knowledge, using real life examples, visuality, continuous learning, using different senses, and being against to rote learning. Science

process skills include terms such as observation, creativity, thinking, imagination, and problem solving. Lastly, psychomotor skills cover the ability to use devices or other instruments in an informal learning environment. The pre-service teachers talked more about different aspects related to student learning after visiting the Science and Technology Museum. They mentioned the significance of informal learning environments with respect to student learning 53 times whereas this frequency increased to 78 after the science museum visit.

As seen in Table 4.5, regarding learning of students' sub-theme under the significance and benefits of informal learning environments theme, the pre-service science teachers mentioned effective learning mostly. In addition, they provided more detailed explanations.

Table 4.5. *Frequencies of Aspects related to Learning of Students under Significance and Benefits Theme*

Learning of students	Frequencies Before the Visit	Frequencies After the Visit
effective learning	45	66
science process skills	8	12
psychomotor skills	-	1

For example; before the visit, PST1 stated about effective learning that "Students can easily learn the subjects by seeing and trying in these environments" but after the visit she mentioned that

> "I did not have any education in museums or other informal learning environments and I learned concepts by memorizing generally in class. For example; plant cell is rectangular, I memorized it and I was confused that for a long time. But if I saw that in the microscope, I would learn more easily, or escalation system, teachers say to us you are pulling yourself with

> escalation system. The higher the rollers, the force is dispersed more, and you can pull yourself out by applying less force. I would not understand the reason and I could not accept this. There is such a mechanism in the Science and Technology Museum and children can understand the topic concretely by seeing and trying."

Moreover, before the visit PST3 said that "Informal learning environments are useful for providing prior knowledge to students before teaching the concepts in the class or reinforcing the subject after teaching in the class." After the visit, she added that "There is not any curriculum or time limitation. I can teach the things that they wondered in detail. Moreover, informal learning environments enable students to make abstract subjects concrete." Additionally, before the visit PST4 mentioned effective learning that "Informal learning environments are useful for reinforcing the knowledge of students that they learned in the class" and after the visit she mentioned that

> "Informal learning environments are useful for teachers. For example, we went to a waste treatment plant within the course in the university. The teacher showed pictures before, but it was not so effective. Observing in there was more effective. It makes teaching easier for the teacher."

Moreover, she mentioned concretization and retention: "Students do not learn the subjects only on the paper, they can use concrete examples and learn the subjects permanently in the informal learning environments."

While PST14 focused only on meaningful learning and retention before the science museum visit, she also considered using different senses in learning process and she added retention to her explanations likewise PST4 after the visit as "Children learn better in science museums since they can try the things by themselves. They can learn more permanently, they can use different senses and more effective learning takes place."

Science process skills and psychomotor skills are the other sub-sub-themes under learning of students. For instance, PST1 and PST2 did not mention science process and psychomotor skills before the visit, however, after the visit, they did. For instance, PST1 said that

> "There is a mechanism about the center of gravity. It is needed to locate the crow's nose to the focal point to prevent the crow from falling. Children will imagine and think and then apply all the procedures in their minds to find the focal point. That is very effective to provide retention in learning."

She also added that "Students also develop their psychomotor skills by doing physical activities in museums." Similarly, PST2 stated that "Students develop their physical skills by doing applications on mechanisms" after the visit.

4.2.3. Learning Environments

This sub-theme is constructed by analysis of the pre-service science teachers' answers about properties of informal learning environments. The pre-service teachers stated the aspects of learning environments 35 times while this frequency decreased after visiting the Science and Technology Museum to 24 times.

Table 4.6 presents the frequencies of aspects regarding learning environment the pre-service teachers stated. The pre-service science teachers mostly focused on social interactions while talking about learning environment both before and after the science museum visit. In addition, they emphasized informal learning environments as relaxing. Students are active and they voluntarily join the activities in these environments. The pre-service teachers thought that there are not many rules, participants are from different age groups, there are more applications, and also there is no grading, no time limitation and students have the opportunity to do wrong and to try again.

Table 4.6. *Frequencies for the Learning Environments*

Learning environments	Frequencies Before the Visit	Frequencies After the Visit
social interactions	8	11
different age groups	3	1
volunteering	7	1
few rules	2	-
no grading	3	-
more applications	5	2
opportunity to do wrong and to try again	1	1
no time limitation	-	1
active student	1	1
relaxing environment	5	6

To illustrate; regarding relaxing environment and no grading sub-sub-themes, PST7 did not mentioned anything before the visit; however, after the visit she stated that

> "There is a tense environment in school. Concerning grades, competition, and being compared with others, and absenteeism all increase students' stress. Worry about being criticized by teachers affects students negatively. However, when a friend told me something, I know no one is judging me. When you love a person, you listen more carefully."

Another pre-service teacher, PST2, did not emphasize the social interactions before the visit but she talked about social interactions after the visit as "Communication with each other or counselors can develop social skills of students. Their communication skills increase." PST17 mentioned social interactions before the visit that is different

from PST2: “Informal learning environments develop social skills.” After the visit, she mentioned the different aspects that there are more applications in informal learning environments, and she stated that “Students can see many different types of snakes when they went to the zoo. This is not possible for them to learn these all types in the class. They can think that there is one type of snake when they see only in books."

4.3. Disadvantages of Informal Learning Environments

This theme includes the views of pre-service science teachers related to disadvantages and difficulties of learning in informal learning environments. There are five sub-themes; instructional difficulties, lack of inspection, financial problems, transportation problems, and bureaucratic procedures. As seen in Table 4.7, the frequencies of disadvantages stated increased after visiting the Science and Technology Museum.

Table 4.7. *Frequencies for Disadvantages of Informal Learning Environments*.

Disadvantages	Frequencies Before the Visit	Frequencies After the Visit
instructional difficulties	23	52
lack of inspection	3	-
financial problems	2	5
transportation problems	-	1
bureaucratic procedures	-	4

Table 4.8 shows the frequencies of instructional difficulties. The pre-service science teachers mostly stated misconceptions as disadvantages before visiting the Science

and Technology Museum, however; they generally stated discipline problems and curriculum-time constraints as disadvantages after visiting the museum.

Table 4.8. *Frequencies of Aspects in Instructional Difficulties*

Instructional difficulties	Frequencies Before the Visit	Frequencies After the Visit
unplanned trip	1	5
discipline problems	5	10
misconceptions	8	6
only enjoying entertainment	1	6
extra labor	2	6
curriculum - time constraint	2	11
dislike to school	2	1
insufficiency of teacher	2	4
safety	-	4
examination system	-	3

They claimed that using informal learning environments without preparation causes an unplanned and pointless trip. To illustrate; before the museum visit PST1 stated that students might view the science museum visits only as an enjoyable activity:

> "Students can see these environments as only enjoying entertainments. For example, there is a ball in the museum, we expect students to deal with the ball in a scientific way, however, they can take the ball and just play with each other."

However, after the visit, she mentioned the unplanned and pointless trips as:

> "Students are unconsciously going to museums. Teachers are also unconscious since they do not have any idea about the place before. Therefore, they could not provide support for students when they go there and it becomes waste of time. For example, there was a tangram activity in the museum. There were some pieces of wood in different shapes and visitors were trying to put the shapes to the places which were indicated in the pictures as a counselor. I couldn't make the letter H from the pieces of woods in the museum. My motivation was decreased and I didn't want to deal with other letters. Someone may need to encourage such cases."

According to the pre-service teachers, preparing the instruction in informal learning environments is an extra labor and responsibility for teachers. For instance, although PST2 did not express these issues before the visit, after the visit she stated that

> "There can be appropriate activities for any students in any environment. I think that informal learning environments provide easiness for teaching, however; the labor of the teacher increases. Teachers must be more careful with the safety of students when compared to the class. It is needed to spend more energy to cope with bureaucratic procedures."

There could be also discipline problems and chaos such as controlling and counseling crowded groups in informal learning environments as PST2 stated:

> "There can be chaos if a teacher goes to informal learning environments with crowded groups. It is difficult for one teacher to control and counsel the students, therefore, there must be at least two teachers according to the number of students on the trip. The teacher must be prepared for the trips to provide effectiveness."

Likewise, PST 3 and PST14 is also stated the discipline problems after the visit as "There can be discipline problems since there is no grading. Students could not mind the teacher in informal learning environments" (PST3); "There could be

discipline problems and it is difficult to control and guide crowded groups with only one teacher" (PST14)

Developing misconceptions and confusions in students' minds are also stated as essential disadvantages. In addition, there are curriculum and time constraints since teachers have limited time to cover the curriculum. They also claimed that if students get used to learning in informal learning environments, they would not want to learn in schools. Insufficiency of the teacher, safety problems, and examination system in Turkey are also stated as other difficulties to use informal learning environments in education. For example, after visiting the museum PST14 talked about misconceptions that:

> "Students could develop misconceptions in informal learning environments or they could confuse something in their mind that is taught in the class. Moreover, they could not listen to their teacher, they may claim that they already learned in informal learning environments."

PST11 also mentioned misconceptions as disadvantages before the visit: "There can be misconceptions. For example, students can get a lot of wrong information while searching on the internet" however, she mentioned different disadvantages after the visit. She referred to the examination system that

> "I think informal learning environments should be included in every ideal education system but if we speak for our education system, students may not like it since there is an exam-oriented system. Students can think that it is unnecessary to use informal learning environments."

PST14 expressed her ideas about curriculum and time constraints and safety problems after the visit as "It is difficult to complete the curriculum in time. Students could see informal learning environments as only for entertainment. They may not focus on learning in there. There must be more than one teacher on the trips to control the students since safety problems could occur."

PST14 also spoke of financial problems after the visit as

> "Financial problems are important disadvantages to use informal education in learning. Students could not have equal opportunities to provide financial support. For example, I attended a project of Scientific and Technological Research Council of Turkey (TUBITAK) and it was not possible for me to cover costs as my own. Accommodation and transportation costs are too high."

Additionally, PST3 mentioned lack of inspection before the visit that "There must be inspections on the places such as hobby courses or workshops. It is dangerous to give permission to everyone to open such places."

4.4. Using Informal Learning Environments in Future as a Teacher

This theme is generated by analyzing the answers of the pre-service science teachers about using informal learning environments when they become teachers. They generally mentioned that they could use informal learning environments to provide effective learning and teaching. Moreover, they stated that informal learning environments could be used for developing positive attitudes in students. Therefore, this theme includes two sub-themes: learning of students and developing positive attitudes. In total, the frequencies for the aspects that the pre-service teachers stated about using informal learning environments in the future increased from 25 to 42 times before and after visiting the science museum.

4.4.1. Learning of students

The pre-service science teachers stated that they would want to use informal learning environments for effective learning and teaching. They particularly emphasized effective learning. Effective learning in that part includes other terms such as comprehensive learning, meaningful learning, concretization, reinforcement, retention, exemplifying, and observation. Effective teaching implies that informal

learning environments provide better techniques and applications to use in instruction. Table 4.9 shows the frequencies of aspects related to learning of students before and after visiting the science museum. As it can be seen in the table, the frequencies increased after the visit.

Table 4.9. *Frequencies of Aspects related to Learning of Students under Using Informal Learning Environments in Future as a Teacher Theme*

Learning of students	Frequencies Before the Visit	Frequencies After the Visit
effective learning	15	26
effective instruction	4	5

To illustrate; before the visit PST9 stated that "I want to use informal learning environments since they are appropriate for teaching science. They provide many opportunities and applications to promote effective learning." Then after the visit she provided more detailed explanation as:

> "I can use informal learning environments after doing the lecture in the class, by this way, retention and concretization increase. More visuals and real examples enable more effective learning. I use natural environments in topics related to ecology and I provide students the opportunity to try by themselves."

Another pre-service teacher, PST10, mentioned that "I can use informal learning environments to promote retention in learning. For example, I teach them to grow a plant by experiencing it" before the visit. Then, she mentioned effective instruction after the visit and she said that "I can use informal learning environments as a reinforcement after lecturing in the class. I can learn student views about the subject that is covered in the trip in detail and therefore I can improve my instruction according to their views."

4.4.2. Developing positive attitudes

Developing positive attitudes in students is another aspect of using informal learning environments in the future as a teacher. The pre-service science teachers stated the terms such as interest, motivation, curiosity, awareness, and enjoyment. However, it can be observed that the frequencies that reflect how many times the pre-service teachers talked about these aspects were lower than the frequencies in the other themes. They mentioned these terms 6 times before the science museum visit and 11 times after the visit. Interest has the highest frequency. Table 4.10 presents the frequencies of the aspects related to developing positive attitudes in students before and after visiting the Science and Technology Museum.

Table 4.10. *Frequencies of Aspects related to Developing Positive Attitudes in Students*

Developing positive attitudes	Frequencies Before the Visit	Frequencies After the Visit
interest	3	6
motivation	1	2
curiosity	1	-
awareness	1	1
enjoyment	-	2

To exemplify; PST2 did not state anything about developing positive attitude before the visit and then she discussed improving student interest after the visit: “I can use informal learning environments in the future since it is a good way for arousing interests of students.” In a similar way, PST8 did not mention student attitudes before the visit, however, she talked about enjoyment after the visit as “I can use informal learning environments in the future since it was very enjoyable for me and I want to make my students’ learning enjoyable as much as possible.” PST6 mentioned before

the visit that “I can use informal learning environments to guide the individuals according to their interests.” However, she broadened her explanation to include motivation and enjoyment after the visit as “Using concrete examples by teaching science is very important since I want to integrate informal learning environments into my formal lectures. Motivation of students increases and they like school more.”

4.5. Assessment of Learning in Informal Learning Environments

This theme includes ideas of the pre-service science teachers about how to assess student learning in informal learning environments. This theme includes two sub-themes as types of assessment and time of assessment.

4.5.1. Types of assessment

Types of assessment indicate the techniques which are mentioned by pre-service science teachers to assess student understanding in informal environments such as worksheets to be filled, students’ views, discussions, quizzes, writings, drawings, What you already know?-What do you want to know?-What you have learned? (KWL) questions, presentations, project, and observing students’ performance. Pre-service science teachers frequently emphasized observation of students’ performance in the museum before the visit. They generally thought that it is difficult to make assessment in informal learning environments or it is not needed to do grading in those environments, therefore; they believed that teachers could observe students’ psychomotor skills or their desire to participate in the activities. However, I should note that the pre-service teachers do not view observation as an assessment technique; they believed that they cannot give grades by observing students; thus, they prefer to use observation just to view how students conduct activities not to assess students. Although the frequency of types of assessment techniques the pre-service teachers stated increased after the Science and Technology

Museum visit, still, pre-service science teachers did not focus on observing students' performance for assessment as seen in the decrease in the frequency of that sub-sub-theme after the visit. On the other hand, pre-service science teachers generally stated that they can get students' views in the class by asking questions about the trip.

Table 4.11. *Frequencies for the Types of Assessment*

Types of assessment	Frequencies Before the Visit	Frequencies After the Visit
worksheets	1	5
student views	6	10
discussion	1	3
quizzes	2	4
writings	1	2
drawings	-	3
KWL questions	-	1
presentations	1	3
project	1	1
observing students' skills	10	2

4.5.2. Time of assessment

Time of assessment describes the pre-service science teachers' ideas about when to assess the learning in informal learning environments. They considered assessment during and after visit to informal learning environments. The frequency of the assessment after the visit to informal learning environments increased after the pre-service science teacher visited the science and technology museum.

Table 4.12. *Frequencies for the time of assessment*

Time of assessment	Frequencies Before Visit	Frequencies After Visit
during	10	6
after	10	15

To exemplify types and time of assessments; PST1 stated before visiting the museum that "I can evaluate the students only by observing. There will be many students, therefore; it is difficult to make grading them." After the visit, she added that "I can give worksheets them to be filled during the visit and I can ask some questions." PST2 is also mentioned that

> "I can take a look at the students' willingness to join. They could not do the activity well but they could understand the topic. We could discuss in the class after the visit. I can see who has been interested, what they have learned. We can prepare posters about the trip in the class."

She stated after the visit that

"I can give worksheets before going on the trip and I can ask them to fill the questions during the visits. In this way, I can be sure that they try to understand the activity on the trip. I can discuss what they have learned in there in the class. I can create a board and students can place photographs into there that they took during the trip. Moreover, I can do a small quiz about the topic in the class after the visit."

4.6. Science and Technology Museum Trip

This theme is constructed by analyzing the ideas of the pre-service science teachers about the Science and Technology Museum trip after the visit. The pre-service science teachers indicated positive and negative sides of the trip they observed when they visited the Science and Technology Museum. Moreover, the pre-service science teachers expressed their ideas after the museum trip.

4.6.1. Positive sides of Science and Technology Museum trip

Positive sides are mentioned more than negative sides. The most frequently mentioned positive sides are the devices in the museum and the seminar that is given by the museum personal about the field trip. Moreover, there was an activity about the current of electricity which was also mentioned in the seminar. Generally, the pre-service science teachers said that they were pleased with the devices, seminar, and activity in the seminar. Few of them expressed that written explanations about devices, counselors in the museum, opportunity to try all things and experiencing such a field trip were also beneficial. Table 4.13 shows the frequencies of positive sides which are stated by the pre-service science teachers.

Table 4.13. *Frequencies of Positive Sides of Science and Technology Museum Trip*

Science museum trip / positive sides	Frequencies
devices	13
seminar	14
activity	4
written explanations about devices	3
counselors in the museum	3
experience	2
opportunity to try all things	2

To illustrate the views of pre-service science teachers about positive sides of the museum trip; PST16 stated that "I liked devices since they are colorful and funny. We used the devices ourselves and our self-confidence increased. This was an unusual experience and there was the opportunity to see the reality of what we learned" and she also added that "I took advantage of the seminar at the beginning of the trip. Experiences of the counselors in the museum were useful. I learned what I should do when I go to a place like that." Additionally, PST17 said that "Having the opportunity

to try all things is very good. Activity which is done at the end of the seminar was very impressive for small students." PST1 also expressed that "I like the mechanism to calculate the carbon footprint. Children generally don't have any idea about the footprint. It is a very nice device to tell the damage that is made by humans to the world. These topics usually are not mentioned in schools."

4.6.2. Negative sides of Science and Technology Museum trip

The pre-service science teachers also explained the negative sides of the science museum trip. They mostly mentioned the devices that did not work in the museum and they generally thought that there must be students in their field trip to experience real teaching in such a place. Moreover, they stated that devices were insufficient for some areas such as chemistry and biology and there were unnecessarily long and insufficient written explanations about the devices. Some of them expressed that the seminar was not useful because it was only a repetition of the lesson in the class about field trips. Architecture and location of the museum and date of the trip are founded as negative sides by the pre-service science teachers. Lastly, few of them claimed that it was not an appropriate field trip for the levels of pre-service science teachers. Table 4.14 demonstrates the frequencies of negative sides that were stated by the pre-service science teachers related to the Science and Technology Museum trip.

Table 4.14. *Frequencies of Negative Sides of Science and Technology Museum Trip*

Science museum trip / negative sides	Frequencies
repetition of the lesson	2
devices that do not work	8
insufficient devices	2
location of the museum	1
architecture of the museum	2

not appropriate to PSTs' levels	3
long or insufficient written explanations	3
date of the trip	1
no meetings with students	9

To exemplify; PST1 stated that

> "There are too old and inadequate devices in the museum. Devices are insufficient for some subjects. There are not any devices about biology. There should definitely be a microscope. Children can disrupt those devices but this problem can be solved by employing more counselors in the museum."

PST12 mentioned that "I don't see the museum adequate. Some materials are always damaged and they remain corrupted for a long time. Written explanations are insufficient. Students should be guided to read the descriptions by counselors. Silence must be provided to understand what we read." Regarding including students into the science museum visit, PST11 expressed that

> "In the science museum, it would be more realistic if we met students in the science museum. We talked very hypothetically, we could have seen things that could be when we faced with the students. Learning environment in the out of school enables different experiences. It is a good experience before being a teacher."

PST13 emphasized the same aspect as

> "When field trips are applied to small age groups, it is more effective. When we went to the science museum, it wasn't very efficient for our level and there was not anything for us. However, if there were students in the museum, I would have practice for teaching, and this would be a nice experience for my profession. Listening the same things that are told in the class again was so boring."

Lastly, PST11 talked about the architecture of the museum: “The area is messy. There may be chaos when 20 students get there. Architecture of the museum could be arranged differently in a way that the visitors will not be affected by each other. I think, there may be compartments to prevent distraction of the visitors’ attention.”

4.6.3. Ideas after Science and Technology Museum trip

This theme includes views of the pre-service science teachers about informal learning environments after the trip. Specifically, the pre-service teachers stated what they have learned as a result of science museum visit. Sub-themes are how to define, how to apply, how to use in future, and how to integrate into the curriculum. The pre-service science teachers indicated that they gained knowledge about definition of informal learning environments; they learned how to apply the field trips, how to use informal learning environments in the future, and how to integrate them into the curriculum after the lecture about the field trip and Science and Technology Museum visit. The most frequently stated ideas about the science museum visit was about how to apply field trips (see Table 4.15).

Table 4.15. *Frequencies of Pre-service Science Teachers’Ideas after the Science and Technology Museum Trip*

Ideas	Frequencies
how to define	9
how to apply	16
how to use in future	3
how to integrate into curriculum	5

For example; PST4 stated that

> "My thoughts changed positively after the lesson. Our teacher mentioned the negative aspects which could develop if we do not be careful. I learned things that I should not do. I learned how to get benefit from informal learning environments as a teacher. I've always been personally used them as a student and I didn't think it could be used by integrating to class lectures for students before the lecture and the trip."

PST16 also stated similar points that "It was useful for me since I have become more aware of benefits of informal learning environments. Information provided by the instructor and counselor in the museum motivated and encouraged us to use informal learning environments in the future." PST11 and PST12 talked about how to define and how to apply; PST11 stated that "I learned what the contents of informal learning environments are comprehensively and I have an idea about how to make activities in these different environments." and PST12 said that "I did not have any ideas about venues of informal learning environments, I had a chance for developing my knowledge about informal learning environments and how to apply such kinds of activities." PST6 similarly stated that "I mentioned the online platforms as informal learning environments before the visit. I learned the field trips after the visit. That is useful for me. I saw the alternatives to use as informal learning environments"

4.7. Summary of Results

Analyses revealed that the pre-service science teachers emphasized everyday informal learning environments before visiting the Science and Technology Museum as places where they use the internet; read books, newspapers, articles, and journals, and developing a hobby. However, after visiting Science and Technology Museum, their ideas shifted to designed environments such as libraries, museums, science centers, zoos, aquariums, observatories, parks, and programs such as seminars, conferences, science clubs, and after school activities.

The pre-service science teachers frequently emphasized the significance and benefits of informal learning environments after the Science and Technology Museum trip. They thought that using informal learning environments is important because of promoting learning of students, developing positive attitudes and providing a better learning environment according to classes in schools.

For assessment in informal learning environments, the pre-service science teachers mentioned the types of assessments as worksheets to be filled, students' views, discussions, quizzes, writings, drawings, KWL questions, presentations, projects and observing students' skills. Additionally, they generally expressed that they can make assessment during and after the museum visit as time of assessments. The pre-service science teachers frequently emphasized that they can get students' views in the class after the activity.

As positive sides of the Science and Technology Museum, devices, seminar, and activity in the seminar were the most frequently stated positive sides in the visit. However, not working devices and not meeting with students in the museum were the most often expressed negative sides in the visit. The pre-service science teachers generally agreed that meeting and communicating with students in the museum could be more useful for their professional development. Moreover, they became more aware about the disadvantages of informal learning environments after the visit. Although they think that informal learning environments provide effective learning, they claimed that it is difficult to integrate informal learning environments into teaching because of curriculum constraint and examination system in Turkey.

Lastly, it is observed that the pre-service science teachers' knowledge about informal learning environments developed after the Science and Technology Museum trip. They learned the venues of informal learning environments comprehensively and they improved their knowledge about application of field trips, using informal learning environments in the future, and integrating these environments into the curriculum.

CHAPTER 5

DISCUSSION, CONCLUSION AND IMPLICATIONS

In this chapter, results of the qualitative data which were gathered to explain the views of pre-service science teachers before and after visiting a science museum will be discussed in conjunction with the related literature. This chapter includes two parts as discussion, and conclusion, implications and recommendations for future research.

5.1. Discussion

Today, informal education is everywhere on television, movies, search engines, and we can find more than we want to learn from these sources. Moreover, there are many different informal learning environments to understand our natural world throughout our life at all ages and informal learning environments will be more important than today in science education (National Science Teachers' Association (NSTA), 2015). Therefore, it is important to learn teachers' views about informal learning environments and teachers must be aware of the opportunities of informal learning (Avraamidou, 2014). The present research is important since it provides detailed information about the views of pre-service teachers about informal learning environments before and after visiting the Science and Technology Museum within the Methods of Teaching Sciences Course I. The views of pre-service teachers were categorized as venues of informal learning environments, significance and benefits of informal learning environments, disadvantages of informal learning environments, using informal learning environments in future as a teacher, assessment of learning in informal environments and the Science and Technology Museum trip.

Knowledge of pre-service science teachers about informal learning environments increased after visiting the Science and Technology Museum. They stated more comprehensive definitions about informal learning environments and included more aspects for venues of informal learning environments in their definitions. Additionally, before the visit they did not have enough idea about the designed environments such as museums, science environments, and zoos, instead they generally mentioned everyday environments and activities such as family conversations, using the internet, and reading. The Science and Technology Museum and the course about field trips in the method course might increase the pre-service teachers' knowledge about informal learning environments and specially designed environments such as science museums. The pre-service teachers started to think more about informal environments that can help to teach science in a better way after the visit and they added some venues to their definition of informal learning environment such as waste treatment places, parks, observatories, and science clubs after the visit. Kisiel (2013) supported that point in his research by comparing pre- and post-class responses of prospective teachers who participated to informal learning environment activities in a semester-long science method course and their ideas about informal learning environments shifted from places for field trips and hands-on experiences to institutions for enriching the science instruction in the class. In a similar way, Bozdoğan (2012) also supported these results by stating that pre-service science teachers who take a course on informal environments and visit different types of informal environments gave detailed information about them at the end of the term.

The pre-service teachers thought that informal learning environments have quite a significance and many benefits such as developing learning of students, promoting effective outcomes, and presenting non-traditional learning environment that is different from school. The pre-service teachers indicated this significance and benefits before the museum visit that means that they generally had positive ideas about informal learning environments. However, the significance and benefits of informal learning environments were stated more frequently after the visit. Visiting the Science and Technology Museum in the course might make pre-service teachers

be more aware and conscious about the significance and benefits of informal learning environments. The pre-service science teachers thought that informal learning environments provide effective, meaningful, and non-rote learning with the opportunity of trial and error, visuality, retention and concretization; science process skills such as observation, creativity, thinking, imagination, and problem solving techniques could be promoted in the informal learning environments; psychomotor skills could be enhanced with the interactive exhibits in the informal learning environments. The Science and Technology Museum visit provided pre-service science teachers to see the opportunities for teaching science in a better way with the materials and rich resources of informal learning environments. Research of Falk and Dierking (1997) about long-term impacts of school field trips supports the results of the study. They stated that meaningful and memorable learning of students occurs in field trips and these learnings could be recalled after many years to apply in future problem-solving tasks. Additionally, consistent with these findings, Sasson (2014) emphasized that there was a significant improvement in the scientific thinking skills of middle school students after they visited a science center. The findings of Adams and Gupta (2014) support these results in their research with teacher candidates who participated in a 15-month teacher education program that included teaching science in museum. They indicated that these informal learning environment experiences encouraged the pre-service teachers to use multiple and rich resources of museums.

The pre-service science teachers in the study thought that enjoyment, interest, curiosity, and motivation are the most important effective outcomes of informal learning environments since they stated them more frequently than the other affective outcomes and they emphasized these affective outcomes more after visiting the museum. The Science and Technology Museum visit provided them to see how to learn science in an enjoyable way since their experience in the museum was enjoyable and interesting, there were experiments that made them more curious and motivated to learn science. Consistent with these findings, Adams and Gupta (2014) stated that informal science institutions make science learning and teaching more strong with the exhibits, visuals, displays and objects in a non-traditional way by developing the

effective and emotional domains of learning such as curiosity, interest, excitement, and motivation. Fenichel and Schweingruber (2010) also stressed that interactive experiences tend to increase and maintain students' interest, motivation, and engagement as well as to develop their knowledge and provide opportunity for reasoning. Similarly, Rumjaun (2017) pointed out that educational visits in science motivate students to learn science by rising their interest and curiosity.

The pre-service teachers frequently focused on social interactions in the informal environments. Additionally, they thought that informal environments are volunteering, relaxing environments and include more applications. Consistent with these findings, Erten and Karademir (2013) indicated that the pre-service teachers thought that out-door science activities promote socialization of students. Ramey-Gassert (1997) stated that learning science in museums is socially interactive, learner-centered, not strictly planned, and voluntarily occurs in relaxed environments. The study of Denson et al. (2015) also provides consistent findings in their research that integration of formal and informal environments has more applications. Although the pre-service teachers mentioned these properties of informal learning environments, they mostly preferred to emphasize the cognitive aspects rather than affective aspects and they emphasized at least properties of learning environments. Properties of informal learning environments mentioned above were not emphasized after the Science and Technology Museum visit. Both the course instructor and counselor in the museum stressed on the cognitive aspects of informal learning environments, therefore, the pre-service teachers might direct their attention to those aspects rather than the properties of informal learning environments.

Regarding the disadvantages of informal learning environments, the pre-service teachers thought that it would be difficult to implement instruction in informal settings because of instructional difficulties, lack of inspection, financial problems, transportation problems, and bureaucratic procedures. The pre-service teachers talked about disadvantages more after the Science and Technology Museum visit than before the visit. This might be because of the fact that they might not have enough ideas about informal learning environments before the visit. In general, the pre-service teachers in

the study stated the following disadvantages of field trips. Preparing the field trips is an extra labor for pre-service teachers. There could be discipline problems or chaos when teacher was not prepared adequately. Students could also think that there is no grading and therefore they may not follow the directions of the teacher. If there are crowded groups, it is difficult to control them, there could be also safety problems. Students may develop misconceptions. Content knowledge, instructional or managing abilities of pre-service teachers could not be sufficient for teaching in informal environments. Educational objectives could not be reached, and field trips are perceived as only enjoyable entertainments. Because of curriculum and time constraints, teachers could escape from planning educational field trips. The examination system in Turkey also might cause the time constraint, since students need to work hard for doing well in the tests. These disadvantages stated by the pre-service teachers in the study are parallel to the findings of other studies in the literature. For example, Michie (1998) summarized seven disadvantages for field trips; "Transportation, teacher training experiences, school schedule and teachers' abilities to prepare, lack of school administrative and financial support, lack of flexibility in the school curriculum, poor student attitudes and behaviors and lack of awareness of teachers for potential sites" (as cited in Rumjaun, 2017, p.429). Bozdoğan and Yalçın (2009) mentioned in their research that financial problems and time constraints are common problems between all visitors of science museums. Consistent with the findings, Anderson et al. (2003), and Hofstein and and Rosenfeld (1996) indicated that students could see informal environments as only enjoyable entertainments not as educational environments.

Science and Technology Museum visit promoted the pre-service science teachers' ideas of using informal learning environments in the future as a teacher to provide effective learning and teaching and also to develop positive attitudes in students. Guisasola and Morentin (2015) support these results by describing the teachers' main objectives for visiting museums in their study; 59.5 % of the teachers stated stimulating motivation, interest and positive attitude towards science; 53.2% of

teachers mentioned the complementing theory in the class with applications of museums and 30.4% mentioned doing scientific experiments in the museum.

The pre-service science teachers generally did not prefer to make grading in informal environments since it is difficult and problematic to do assessments in informal environments. However, as a contrast to these findings, it is needed to make assessments in informal environments according to Anderson et al. (2003). Anderson et al. (2003) indicated in their research that post-visit activities must be designed and applied by teachers to understand their students' learning in museums. Post-visit activities also help to promote learning in museums. Fenichel and Schweingruber (2010) stated that traditional measures such as testing in museums and science centers are not appropriate for assessing the outcomes of these informal environments and they advised that assessment in informal environments should include cognitive, affective, behavioral and social outcomes, assessments should match with the type of the experienced activity, and validity must be concerned while assessing. The most applicable way of assessing outcomes of educational visits are long-lasting projects that provide to assess the whole process of learning (Ramey-Gassert, 1997).

The pre-service science teachers emphasized the positive sides of the Science and Technology Museum trip more frequently than the negative sides after the museum visit. The devices in the museum and seminar that was given by the counselor in the museum about their experiences in the museum might be beneficial for the pre-service teachers and therefore, they might frequently emphasize them as positive sides of the Science and Technology Museum trip. As a negative side of the visit, the pre-service teachers stated the absence of students in the museum. Tal (2012) also emphasized the importance of the student and pre-service teacher interaction in informal learning environments since pre-service teachers could observe, practice, and reflect their theoretical accumulation in such real and rich environments. Thus, museum visits can be organized to include students so that pre-service teachers have the opportunity to interact with students to get better experience in informal environments.

The pre-service teachers in the study indicated that their knowledge about informal learning environments improved, particularly they learned how to define informal environments, how to apply field trips, how to use informal environments in the future in their professional life, and how to integrate informal environments to the curriculum. These findings are similar to the results of Atmaca (2012). The pre-service teachers in that study also highlighted the contributions of informal environments to their knowledge and practice of science teaching and they agreed to use these environments in the future. Engaging pre-service teachers in informal learning environments are useful because, as Behrendt (2017) stated, they would become more excited for introducing their students about the informal learning environments in the future when they attended to informal learning environments in their teacher education program. Many science teachers do not use informal environments since they are unaware of how to connect informal education to formal education and what the sources and materials of informal environments are (Ramey-Gassert, 1997). Therefore, integrating informal learning environments into the teacher education programs provide pre-service science teachers to be confident while using informal environments in the future.

5.2. Conclusion

The views of pre-service teachers on informal learning environments before and after visiting the Science and Technology Museum were explored in the present study. Instruction about field trips and integrating the Science and Technology Museum visit into the program of the science teaching methods course generally provided the pre-service science teachers to make more comprehensive explanations and give more detailed information about informal learning environments. The pre-service science teachers became more aware of venues of informal environments that support the school curriculum such as science museums. The Science and Technology Museum visit provided pre-service teachers to understand how and for what purposes they could use informal environments -and field trips- in the future and they gained insight

about how to integrate informal learning environments into curriculum and their instruction in the class. In addition, the Science and Technology Museum visit increased consciousness of the pre-service science teachers about the disadvantages of informal learning environments. On the other hand, the pre-service science teachers did not have enough idea about assessing the process of learning in informal learning environments. Overall, the pre-service teachers in the study improved their knowledge about informal learning environments, application of field trips, using informal learning environments in the future, and integrating these environments into the curriculum after the Science and Technology Museum visit.

5.3. Implications and Suggestions for Practice and Future Research

This study highlights the importance of science museum visits in teacher education programs to enhance pre-service science teachers' views about informal learning environments. Therefore, teacher educators should enrich the science method courses with the informal learning environments. Informal learning environments should be emphasized with all aspects in a detailed way in teacher education programs. Teacher educators should use informal learning environments to provide pre-service teachers opportunity to observe and apply the theory of teaching in a real environment with the students.

Informal learning environments promote effectiveness in the learning of students, develop affective outcomes, and provide a non-traditional learning environment that is different from school. Pre-service and in-service teachers should give more importance to informal learning environments in science education. They should investigate the sources and materials of informal learning in their environment to enhance teaching and learning science. To illustrate, in-service teachers should visit the website of the Science and Technology Museum in METU. They should analyze the devices and the catalog about the devices. There are explanations about relation of devices with the objectives of the curriculum at different levels. They should use these

devices to draw interest of students to subjects or reinforce and strength the understanding of the subjects that is learned in the class. School administrators should support the teachers to integrate informal environments into the objectives of the curriculum.

Pre-service science teachers should learn the ways for struggling with the disadvantages of informal learning environments in teacher educator programs. Pre-service science teachers should have the opportunity to experience teaching and learning in informal learning environments through their university education. The absence of students in the museum was a very important deficiency for the pre-service science teachers since they could not have the opportunity of observing and applying the theory of teaching in a real environment with the students. Educators in informal environments should support teacher educators for using informal environments in teacher education programs and design the informal environments according to provide meetings of students and pre-service teachers. In addition, because the pre-service teachers in this study had poor knowledge about how to make assessment in informal learning environments, teacher educators should give more importance to the application of appropriate assessment techniques in such environments. For example, they can integrate alternative assessment methods into field trips to provide examples for pre-service teachers.

This study provided general explanations about the views of pre-service science teachers about informal learning environments. The main recommendation for future research is to investigate the informal learning environments in a deep and specific way. This study can be replicated with different participants such as pre-service teachers from different subject areas (chemistry, biology, and physics) to get more knowledge about teachers' views about informal learning environments. Different types of informal learning environments such as natural environments or after school programs can be examined. Additionally, informal environments in this study were used for approximately three hours and therefore, this study can be replicated by using informal environments for long time intervals. This study was a qualitative research and data gathered only by the interviews. Thus, this study can be

replicated by using different data gathering sources or supporting the qualitative data with the quantitative data.

REFERENCES

Adams, J.D., Gupta, P., (2017). Informal science institutions and learning to teach: An examination of identity, agency, and affordances. *Journal of Research in Science Teaching*, 54(1), 121–138.

Agarkar, S., Brock, R. (2017). Learning theories in science education. In K. S. Taber, B. Akpan (Ed.), *Science education: An international course companion*, Netherlands: Sense Publishers, 31, 93-105.

Airasian, P.W., Walsh, M.E. (1997). Constructivist cautions. *Phi Delta Kappan*, 444-449.

Anderson, D., Lucas, K. B., Ginns, I. S.(2003). Theoretical Perspectives on Learning in an Informal Setting, *Journal of Research in Science Teaching*, 40(2), 177-199.

Atmaca, S. (2012). *Outdoor education activities in science education and effects of these activities on pre-service teachers. (Doctoral dissertation)*. Hacettepe University Institute of Social Sciences, Ankara.

Avraamidou, L. (2014). Developing a reform-minded science teaching identity: the role of informal science environments. *Journal of Science Teacher Education, 25*(7), 823-843.

Avraamidou, L. (2015). Reconceptualizing elementary teacher preparation: A case for informal science education. *International Journal of Science Education*, 37(1), 108-135.

Behrendt, M. (2017) Examination of a Containing Active Science Club: A Case Study. *Science Educator*, 25, 82-87.

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (Ed.). (2009). *Learning science in informal environments: People, places, and pursuits*. Publisher: National Academies Press, Retrieved from http://www.tandfonline.com/doi/full/10.1179/msi.2009.4.1.113

Birinci Konur, K., Şeyihoğlu, A., Sezen, G., & Tekbıyık, A. (2011). Evaluation of a science camp: Enjoyable discovery of mysterious world. *Educational Sciences: Theory & Practice*, 11(3), 1589-1608.

Bjork, R.A., Druckman, D., (Ed). (1994). *Learning, remembering, believing: enhancing human performance.* Washington, D.C.: National Academy Press.

Bodner, G. M. (1986). Constructivism: a theory of knowledge. *Journal of Chemical Education*, 63, 873-878.

Bozdoğan, A. E. (2008). Planning and evaluation of field trips to informal learning environments: case of the energy park. *Journal of Theory and Practice in Education*, 4(2), 282-290.

Bozdoğan, A. E. (2008). The Assessment of the science centers of the pre-service science teachers in terms of science education: The case of Feza Gürsey Science Center. *Faculty of Education Journal*, 21 (1), 19-41.

Bozdoğan, A. E., Yalçın N. (2009). Use levels of science and technology museums for education in Ankara. National Education, 182, 232-248.

Bozdoğan, A.E. (2012). The practice of prospective science teachers regarding the planning of education based trips evaluation of six different field trips. *Educational Sciences: Theory & Practice*, 12(2), 1049-1072.

Can, M. H. (2013). Investigating elementary school students' behaviors at a science center. *Education and Science*, 38(168), 347-361.

Coll, S. D., & Coll, R. K. (2017) Using blended learning and out-of-school visits: pedagogies for effective science teaching in the twenty-first century, *Research in Science & Technological Education*, 36(2), 185-204.

Cratty B. J., Noble C. E. (2019). Psychomotor Learning. Retrieved June 10, 2019, https://www.britannica.com/science/psychomotor-learning.

Creswell, J. W. (2007). *Qualitative inquiry and research design: choosing among five approaches.* Thousand Oaks, California: Sage Publications.

Çavuş, R., Topsakal, Ü.U., & Kaplan, A.E. (2013). Teachers views' on awareness of environmental acquiring in informal learning Environments: The sample of Kocaeli Science Houses. *Pegem Journal of Education and Instruction*, 3(1), 15-26.

Denson, C. D., Hailey, C., Stallworth, C. A., & Householder, D. L. (2015). Benefits of informal learning environments: A focused examination of STEM-based program environments. *Journal of STEM Education: Innovations and Research*, 16(1), 11–15.

Dillon, J. (2012), Science, the environment and education beyond the classroom, in B.J. Fraser, K. Tobin and C. McRobbie eds., Second International Handbook of Science Education, Springer, Netherlands, 1081–1095.

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: implications for the design and delivery of instruction. *Handbook of Research for Educational Communications and Technology*, 170–198. https://doi.org/10.1111/j.1467-8535.2009.00994_9.x

Ertaş, H., Şen, A.İ., Parmaksızoğlu, A. (2011). The effect of out-of-school activities on 9th grade students' relating the unit of energy to daily life. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education.* 5(2), 178-198.

Eshach, H. (2007). Bringing in-school and out of school learning: Formal, non-formal and informal education. *Journal of Science Education and Technology*, 16(2), 171-190.

Falk, J.H. and Dierking, L.D. (1997). School field trips: assessing their long-term impact. *Curator*, 40 (3), 211-218.

Fenichel, M., & Schweingruber, H. A. (2010). *Surrounded by science: learning science in informal environments*. Washington, DC: National Academies Press.

Gilbert, J., Priest, M. (1997). Models and discourse: a primary school science class visit to a museum. *Science Education*, 81(6), 749-762.

Glackin, M. (2016). 'Risky fun' or 'Authentic science'? How teachers' beliefs influence their practice during a professional development program on outdoor learning. *International Journal of Science Education*, 38(3), 409-433.

Glackin, M., Harrison, C. (2018). Budding biology teachers: what have botanical gardens got to offer inquiry learning. *Journal of Biological Education*, 52(3), 1-11.

Glasersfeld, E. von (2007). Key works in radical constructivism. In M. Larochelle (Ed.), Netherlands: Sense Publishers.

Gupta, P., Adams, J. (2012). Museum-university partnerships for pre-service science education. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education*, New York, NY:Springer, 1146-1161.

Harrison, W. J. & Lodge, J. M., (2019). The role of attention in learning in the digital age. *Yale Journal of Biology and Medicine*, 92(1), 21–28.

Hein, G.E. (1995). The constructivist museum, *Journal of Education in Museums*, 16, 21-23.

Hofstein, A., Rosenfeld, S. (1996). Bridging the gap between formal and ınformal science learning. *Studies in Science Education*, 28(1):87-112.

Hsu, P. L. (2016). Science teaching experiences in informal settings: One way to enrich the preparation program for preservice science teachers. *Universal Journal of Educational Research*, 4(5), 1214-1222.

Jackson, C., Mohr-Schroeder, M., Little, D. L. II., (2014). Using informal learning environments to prepare pre-service teachers. *Teacher Education and Practice*, 27 (2-3), 445-463.

Karademir, E. & Erten, S. (2014). Determining the factors that affect the objectives of pre-service science teachers to perform outdoor science activities. *International Journal of Education in Mathematics, Science and Technology*, 1(4), 270-293.

Katz, P., McGinnis, J., Hestness, E., Riedinger, K., Marbach-Ad, G., Dai, A., Pease, R. (2011). Professional identity development of teacher candidates participating in an informal science education internship: a focus on drawings as evidence. *International Journal Science Education*, 33(9), 1169–1197.

Katz, P., McGinnis, R., Riedinger, K., Marbach-Ad, G., & Dai, A. (2013). The influence of informal science education experiences on the development of two beginning teachers' science classroom teaching identity. *Journal of Science Teacher Education*, 24, 1357–1379.

Kırıkkaya, E.B., Bozkurt, E. (2011). Effect of TÜBİTAK supported primary school students science summer school on students' image of scientist. *Mediterranean Journal of Education Research*, 1(9), 61-75.

Kim, M. & Dopico, E. (2016). Science education through in formal education. *Cultural Studies of Science Education*, 11(2), 439-445.

Kisiel, J. (2013). Introducing science teachers to science beyond the classroom. *Journal of Science Teacher Education*, 24, 67–91.

Kisiel, J. F. (2014). Clarifying the complexities of school-museum interactions: perspectives from two communities. *Journal of Research in Science Teaching*,51(3), 342-367.

Koballa, T. R., Glynn, S. M. Attitudinal and motivational constructs in science learning. Lederman, N. G., Abell, S. K. (Ed) (2007). *Handbook of research on science education.* London: Routledge

Lin, A. C. H., Gregor, S. (2006). Study of museum experiences. international review of research in open and distance learning, 7(3).

Marriam, S. B. (2009). *Qualitative research*. San Francisco, CA: Jossey-Bass.

McGinnis, J.R., Hestness, E., Riedinger, K., Katz, P., Marbach-Ad, G., & Dai, A. (in press). Informal science education in formal science teacher preparation. In K. Tobin, B. Fraser, & C. McRobbie (Eds.), *Second international handbook of science education*. The Netherlands: Kluwer.

Mclaughlin, D. (2015). Investigating preservice teachers' self-efficacy through saturday science, *Journal of College Science Teaching*, 45(1), 77-83.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook.* Thousand Oaks, California: Sage Publications.

Morentin, M., & J. Guisasola. (2015). Primary and secondary teachers' ideas on school visits to science centres in the Basque Country. *International Journal of Science and Mathematics Education*, 13(1), 191-214.

National Science Teachers' Association, Teaching for Conceptual Understanding in Science, (2015). What role does informal education have in developing conceptual understanding? Retrieved from www.nsta.org.

Newell, A. D., Zientek, L. R., Tharp, B. Z., Vogt, G. L., & Moreno, N. P. (2015). Students' attitudes toward science as predictors of gains on student content knowledge: Benefits of an after-school program. *School Science and Mathematics*, *115*(5), 216-225.

Osborne, J. F., (1996). Beyond Constructivism. *Science Education*, 80(1), 53-82. https://doi.org/10.1207/S15327833MTL0502

Padila, M. J. (1990). The science process skills. *Research matters- to the science teachers.* NARST publication, 9004. Retrieved from https://www.narst.org/publications/research/skill.cfm

Patton, M. Q. (2015). *Qualitative research and evaluation methods: integrating theory and practice.* Thousand Oaks, California: Sage Publications.

Ramey-Gassert, L. (1997). Learning science beyond the classroom. *The Elementary School Journal*, 97(4), 433–450.

Rennie, L. Learning science outside of school. Lederman, N. G., Abell, S. K. (Ed) (2006). *Handbook of research on science education.* London: Routledge.

Rennie, L. (2015). John Falk and Lynn Dierking: building the field of informal/free-choice science education. *Cultural Studies of Science Education,* 11 (1), 127-146.

Sample McMeeking, L. B., Weinberg, A. E., Boyd, K. J., & Balgopal, M. M. (2016). Student perceptions of interest, learning, and engagement from an informal traveling science museum. *School Science and Mathematics*, 116(5), 253-264.

Sasson, I. (2014). The role of informal science centers in science education: Attitudes, skills, and self-efficacy. *Journal of Technology and Science Education*, 4(3), 167–180.

Schauble, L., Leinhardt, G., & Martin, L. (1997). A framework for organizing a cumulative research agenda in informal learning contexts. *Journal of Museum Education*, 22(2&3), 3-8.

Southerland, S.A., Sinatra, G.M., & Matthews, M.R. (2001). Belief, knowledge, and science education. *Educational Psychology Review*, 13(4), 325-351.

Spector, B. S., Burkett, R., & Leard, C. (2012). Derivation and implementation of a model teaching the nature of science using informal science education venues. *Science Educator*, 21(1), 51-61.

Subramaniam, K., Asim, S., Lee, E.Y., Koo, Y. (2018). Student Teachers' Images of Science Instruction in Informal Settings: A Focus on Field Trip Pedagogy. *Journal of Science Teacher Education*, 29(4), 307-325.

Swan, K. (2005). A constructivist model for thinking about learning online. In J. Bourne & J. C. Moore (Eds), Elements of Quality Online Education: Engaging Communities. Needham, MA: Sloan-C.

Şentürk, E. (2009). *The effect of science centers on students' attitudes towards science*. Master Thesis, Middle East Technical University, Ankara.

Tal, T. (2012). Out-of-school: learning experiences, teaching and students' learning. In B. J. Fraser, K. G. Tobin, & C. J. McRobbie (Eds.), *Second international handbook of science education*. Dordrecht, The Netherlands: Springer, 1109-1122.

Wallace, C. S. (2013). Promoting shifts in preservice science teachers' thinking through teaching and action research in informal science settings. *Journal of Research in Science Teaching,* 24, 811– 832.

Wandersee, J. H., Clary, R. M. (2006). Fieldwork: New directions and exemplars in informal science education research. In Mintzes and Leonard (Eds.), *Handbook of College Science Teaching (Chapter 17)*. Arlington, VA: National Science Teachers Association Press, 147-176.

Watkins, C., Carnell, E., Lodge, C., Wagner, P., & Whalley, C. (2002). Effective learning. (The National School Improvement Network Research Matters Series No. 17), London, UK: University of London, Institute of Education. Retrieved July 25, 2019 from http://discovery.ucl.ac.uk/10002819/1/Watkins2002Effective.pdf

Whitesell, E. R. (2016). A day at the museum: The impact of field trips on middle school science achievement. *Journal of Research in Science Teaching,* 53(7), 1036-1054.

Yanowitz, K. L. (2016). Students' perceptions of the long-term impact of attending a "CSI Science Camp". *Journal of Science Education and Technology*, 25(6), 916–928.

Zoldosova, K., Prokop, P. (2006). Education in the field influences children's ideas and interest toward science. *Journal of Science Education and Technology*, 15(3), 304–313.

APPENDICES

A. INTERVIEW QUESTIONS

Interview Questions Before the Visit

1. What do you think about informal learning environments and what do you know about these environments?
2. Did you get any education in informal learning environments through your educational life? Could you give information about your experience, if you have?
3. Do you find informal learning environments beneficial as a student? Why?
4. Do you find informal learning environments not useful as a student? Why?
5. Do you find informal learning environments beneficial as a teacher? Why?
6. Do you find informal learning environments not useful as a teacher? Why?
7. How do informal learning environments affect your education, if you take your university courses in informal learning environments?
8. Are you a member of any science club in the university? Which one? What are the club activities? What is your role in the club? How do you evaluate science clubs as an informal learning environment?
9. How do informal learning environments affect your students?
10. Would you use informal learning environments as a teacher? Why and how?
11. How do you make assessment and evaluation in informal learning environments?
12. Do you think to what extent informal learning environments could be integrated to the curriculum? Why?

Interview Questions After the Visit

1. What do you think about informal learning environments and what do you know about these environments?
2. Did you get any education in informal learning environments through your educational life? Could you give information about your experience, if you have?
3. Do you find informal learning environments beneficial as a student? Why?
4. Do you find informal learning environments not useful as a student? Why?
5. Do you find informal learning environments beneficial as a teacher? Why?
6. Do you find informal learning environments not useful as a teacher? Why?
7. How do informal learning environments affect your education, if you take your university courses in informal learning environments? Did you evaluate your Science and Technology Museum visit according to that?
8. What did you like most in the museum? Why?
9. What was beneficial in the museum according to you? Why?
10. What are the positive aspects of the museum visit? Why?
11. What are the negative aspects of the museum visit? Why?
12. Would you take your students to such a museum visit? Why?
13. Would you use informal learning environments as a teacher? Why and how?
14. How do you make assessment and evaluation in informal learning environments?
15. Are you a member of any science club in the university? Which one? What are the club activities? What is your role in the club? How do you evaluate science clubs as an informal learning environment?
16. How do informal learning environments affect your students?
17. Do you think to what extent informal learning environments could be integrated to the curriculum? Why?
18. Did your ideas about informal learning environments change after the Science and Technology Museum visit? How?