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Investigation of Science Teachers' Professional Development Needs for Learning in Science Centers

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Abstract

Science centers are one of the out-of-school learning environments in science education that have been increasing in numbers in recent years. Due to their importance for increasing both science-society communications and the quality of the education in schools, science centers are one of the focal points for the research conducted in out-of-school learning context. The study of science teaching in the field of science centers in Turkey is mostly confined to the schools or visitors' opinions about individual trips, yet; teachers' professional qualifications and needs related to teaching-learning in science centers are not sufficiently taken into account. This study is part of BİLMER project supported by TÜBITAK (Scientific and Technological Research Council of Turkey) 1001 program and it aims to determine the science and mathematics teachers' professional development needs and their experiences for learning in science centers. In this study, the data were collected with BİLMER Teacher Questionnaire developed for the first time in Turkey. 355 science and mathematics field teachers working in 66 different provinces of Turkey, mainly in the provinces where science centers are located, participated in the questionnaire. According to the data obtained, teachers emphasize the high educational value of the activities organized in science centers; although they face various difficulties, they express that they do not receive enough education according to their professional qualifications. In addition, it has been determined that teachers need professional development on how to integrate activities in science centers, how to collaborate with science center explainers, and what kind of learning approaches can be used in science centers. These data were discussed in line with the relevant literature and suggestions were made for a professional development training to be given to teachers.

Keywords

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Introduction

Today, science has become more independent, professionalized and autonomous than the past due to the scientific knowledge gap between scientists and society as a results of the increase in the scientific knowledge which is produced and increased exponentially every year (Dursun, 2010). The growing difference between the perceptions of scientists, science writers and science politicians towards science and the importance of science, and the perceptions of individuals in the society has led to the emergence of a new field called "Science Communication (Sless & Shrensky, 2001). Although there are different approaches and models to science communication, historically, it is seen that there is a tendency from 'public understanding of science' approach to 'public engagement with science' approach (Trench et al., 2014). Considering the fact that individuals in the community spend most of their lives outside of schools (TVs, printed publications, museums, science centers, zoos, aquariums, etc.), it becomes clear how important the learning environments outside the school are regarding science communication and engagement with science. Indeed, in many scientific research reports, it is reported that out-of-school learning environments, such as science center, contribute to the visitors' science learning and understanding, desire to learn science, career choices, their interest and attitude towards science, scientific literacy, and the development of psychomotor skills by means of various activities carried out (science shows, school trip, workshop, planetarium shows, science festivals, sky observation events, etc.) (Şentürk, 2015).

In addition to the increase in the gap between science and society in many countries, including Turkey, especially the majority of secondary and high school students, think that science and technology-related courses are boring and difficult to learn (Barmby, Kind, & Jones, 2008; Gezer, Köse, & Bilen, 2007; House of Lords, 2000; Jenkins & Pell, 2006; Matthews, 2007; Pedretti, 2004; Sjøberg & Schreiner, 2005). It is emphasized in the literature that one of the most important reasons of this situation is that science is taught to students as a pile of information without presenting environments that helps to arouse interest in science (Dal, Özdem, Öztürk, & Alper, 2013; Pedretti, 2004). As a matter of fact, international comparison and evaluation reports such as TIMSS (Third International Mathematics and Science Study) and PISA (Program for International Student Assessment) show that not only in Turkey but also globally students' negative attitudes towards science and technology are increasing (OECD, 2006).

Learning according to social constructivism theory can be defined as the process of structuring information by interpreting the experiences acquired as a result of interaction with the individual's environment with active mental processes (Köseoğlu & Kavak, 2001). In this process, not only the experiences acquired at school but also the interactions of people with their environment in out-of-school environments and the dialogue with other individuals affect learning (National Research Council [NRC], 2009). Out-of-school learning related to science is shaped by many different sources. Scientific journals, television and radio programs, newspapers, the internet, and personal experiences especially in the field of health are some of these sources. Science centers are the most important ones in terms of being interactive and appealing to all segments of society for Science Education among out-of-school learning environments (Şentürk & Özdemir, 2014). In this direction, science centers are used to improve the quality of both science and society communication and education in schools since the beginning of the 2000s.

Science centers are environments where entertainment and learning are under the same roof (Weitze, 2003), where visitors can experience objects by touching and playing (Quin, 1990), and by associating scientific knowledge with daily life and presenting it to the public (Persson, 2000). The primary aim of the science centers is to contribute to the development of society's scientific understanding through the various learning opportunities offered to them (Medved & Oatley, 2000). The different aims of science centers also include introducing widely accepted scientific principles and strengthening the understanding of the philosophy of science (Rennie, 2007). All the experiences in the science center allow visitors to establish connections between the real world and science, to look at the

world from a scientist's perspective, and to sympathize with science and technology (Dal et al., 2013; Ramey-Gassert, Walberg, & Walberg, 1994). Although science centers are visited by people from all walks of life and from all age groups (NRC, 2009), various research and reports indicate that the majority of science center visitors are students who come with school groups or their families (Şentürk & Tahancalio, 2017; Price & Hein, 1991). School groups also constitute the most important target group of science centers (Rennie & McClafferty, 1995). Therefore, the fact that the activities at the science centers are also supportive of the learning in the school for students is especially important for the teacher and teaching program that aims to provide students with specific learning outcomes (Özdem, Köseoğlu, & Aktaş, 2018). The conducted research reveal that the education program carried out in accordance with the targeted achievements in the science center develops the students' attitudes in the intended way (Ateş, Ural, & Başbay, 2012). Additionally, research have shown that students spend more time with larger and more interesting models in science centers and can better remember and describe them scientifically than others (Bozdoğan, 2007). Similarly, science teacher candidates defined science centers as effective environments for students for permanent learning, gaining science literacy, and developing positive attitudes towards science (Bozdoğan, 2008). Therefore, to increase the number of students with science and technology literacy and to make students gain better understanding on how the natural world works by associating what they learn with daily life in school, the gains associated with learning in out-of-school environments, such as science centers, have been among the main objectives of science courses in many countries (NRC, 2000, 2009).

Research have shown that visits to a science center affect student attitudes positively, make them gain self-perception, self-confidence, self-efficacy, and personal productivity, as well as improve communication skills, creativity, and various personal and social skills (Rickinson et al., 2004). While science center visits have both positive affective and cognitive results for students, it is stated that certain strategies such as preliminary preparation and post-travel monitoring have greatly influence the student's gains and learning from these visits (Kisiel, 2005). Scientific research indicates that the integration of activities in science centers into the classroom by teachers can affect the attitudes of the students positively towards science, which decreases especially after the age of 11 (Falk & Dierking, 1997; Osborne, Simon, & Collins, 2003; Pace & Tesi, 2004). Teacher's aim to visit science center, planning, implementation and post-visit learning are effective in the realization of the targeted gains by the students. Accordingly, the teacher has to play a central role in the science center experience (Falk & Dierking, 1997; Hein, 1998).

Although teachers who play a central role consider science centers as an important experience, they may not be aware of how they can benefit from these learning environments to support learning. As a matter of fact, it is observed that most of the preparations of the teachers for their visits to the science centers are mostly technical preparations (transportation, permissions, food needs of students during the trip, etc.) (Griffin & Symington, 1997). In addition, during this preparatory phase, teachers often do not define their goals for their visit to the science centers, they rarely plan or implement their activities; and the activities of the science centers are perceived as an interesting socio-cultural learning experience but not an opportunity to learn (Cox-Petersen, Marsh, Kisiel, & Melber, 2003; Griffin, 2012; Griffin & Symington, 1997; Kisiel, 2003; Price ve Hein, 1991). Similarly, it was stated in research that teachers cannot associate their experience in science center with the curriculum before, during, or after a visit to a science center and often cannot turn science center visit into an opportunity for learning for students (Griffin & Symington, 1997; Tuckey, 1992). It is observed that even if they had the intention to link the exhibitions in science centers and in-class activities and applications, teachers were unable to achieve these goals because of their other perceptions or concerns (Anderson & Zhang, 2003; Kisiel, 2005).

As a result, it can be said that teachers are not sufficiently conscious of how they can benefit from science centers (Cox-Petersen et al., 2003; Cox-Petersen & Pfaffinger, 1998; Griffin & Symington, 1997; Kisiel, 2003; Ramey-Gassert et al., 1994; Tal, Bamberger, & Morag, 2005). Due to these reasons, in

recent studies, attention is paid to the need for professional development programs and models, which include various basic elements such as field knowledge and pedagogical field knowledge, which will integrate the science center environments to in-class teaching (Pecore, Kirchgessner, & Carruth, 2013). However, it is observed that the impact of these programs on teachers or the number of published studies on which out-of-school learning environment is successful is limited (Melber & Cox-Petersen, 2005). In these studies, it is emphasized that there should be professional development opportunities for teachers that focus on science center regarding supporting learning and associating it with the curriculum.

According to Astor-Jack, McCallie, and Balcerzak (2007), the main purpose of professional development programs is to enhance the learning of students by enriching the teacher's research-based science teaching practices. According to Melber and Cox-Petersen (2005), the aim of teacher professional development programs should be generally (1) communicating with scientists and conducting scientific research with them, (2) enriching the scientific knowledge of teachers, and (3) developing inquiry-based science lessons in line with national science education standards. Garet, Porter, Desimone, Birman, and Yoon (2001) examined many out-of-school learning professional development programs and stated that these programs contain some common components, and that the programs containing these components positively affect teachers' knowledge and skills as well as their classroom performance. According to the researchers, these components are: (1) field knowledge (both scientific content and pedagogical field knowledge), (2) learning by doing and hands-on experiences, (3) transferring experiences gained in professional development education to classroom activities. In some recent studies, it is emphasized that these professional development programs should include at least 30 hours of training and constructive learning approaches should be taken as the basis in the implementation of the training (Adey, Hewitt, Hewitt, & Landau, 2004; Joyce & Showers, 1995; Holliday, Lederman, & Lederman, 2013). On the other hand, a good and effective teacher professional development program (PDP) should be capable of responding to the professional needs of teachers. PDP of a good quality should first start with needs analysis studies to determine the deficiencies of teachers' knowledge and to complete these deficiencies, the necessary professional support should be provided taking the school environment in which teachers work into account (Angadi, 2013). When investigating how this support should be sought, a limited number of studies are being carried out by science centers and museums, which provide professional development programs for teachers (for example; Exploratorium, San Francisco Museum; Boston Science Museum, Denver Natural History Museum). It has been reported that the majority of out-of-school learning centers in the United States are providing professional development programs for teachers and that many teachers participate in professional development programs offered by such environments (Center for Informal Learning and Schools, 2004). Since 1984, it has been observed that the Exploratorium Teacher Institute has implemented different professional development programs for teachers. Although the content of these programs is not shared with the researchers in detail, it is emphasized that in these types of professional development programs, teachers should work interactively with each other, with science educators and Museum teachers to enrich their knowledge in science and technology, participate in practical classroom activities in schools and take training on teaching strategies. In Turkey, there are no studies investigating the professional development needs of teachers for learning in science centers and how to be included in a training program according to these needs.

In the direction of these needs and discussions, some research were carried out on a teacher's professional development model to increase the effectiveness of science centers in science-society communication and science education in Turkey within the scope of BILMER project (TÜBITAK 1001 programs, No: 114K646). In order to establish an effective professional development model within the scope of the project, and to determine the professional development needs and expectations of teachers, science center trainers and managers, needs analysis studies were carried out in Turkey. Regarding relevant international literature, it is seen that out-of-school learning environments like science

museums and teachers' roles, experiences and perceptions related to field trips to these environments are particularly investigated (Chin, 2004; Clarke-Vivier & Lee, 2018; Cox-Petersen et al., 2003; Griffin & Symington, 1997; Morentin & Guisasola, 2015; Olson, Cox-Petersen, & McComas, 2001; Tal et al., 2005; Tal & Steiner, 2006). The aim of this paper, which is part of BILMER project, is to determine the experiences and opinions of the teachers about the science center by the first time developed in Turkey "BILMER Teacher Questionnaire", and to discuss these findings in terms of the basic elements that should be included in the model of teacher professional development. Therefore, the research questions studied in this study are as follows:

1- What are the opinions of teachers of science and mathematics field about the professional development activities?

2- What are the opinions and experiences of teachers of science and mathematics in science centers?

3- What are the professional development needs of science and mathematics teachers about learning in science centers?

The data obtained from BILMER Teacher Questionnaire are discussed in line with the relevant field literature and recommendations are made on the general characteristics of professional development training in accordance with the needs of teachers in Turkey.

Method

Type of Research

This study was carried out with survey method of quantitative research methods. Survey research is carried out with a large number of participants. Survey research can be conducted to determine the characteristics of the participants such as their interest, skill, opinion, attitude, and the ability for a subject or situation (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2014). In this study, data were obtained by using the BILMER Teacher Questionnaire developed to determine the profiles of physics, chemistry, biology, mathematics and science teachers, their professional development status, their experience in science centers, and their professional development needs especially for science centers.

Research Group

Since it is aimed to work with teachers in the fields of Science and Mathematics in line with the research questions of the study and the objectives of the BILMER project, Physics, Chemistry, Biology, Mathematics and science teachers who work in Turkey constitute the universe of the study. In this regard, the questionnaire as a result of the interviews with the General Directorate of Teacher Training and Development, were sent to teachers who especially work in the 18 provinces (Ankara, Antalya, Bursa, Çanakkale, Elazığ, Eskişehir, Gaziantep, Istanbul, Izmir, Karaman, Kayseri, Kocaeli, Konya, Malatya, Mersin, Sakarya, Samsun, Trabzon) where there is a science center or scheduled to open science center in Turkey. For this reason, typical case sampling, one of the purposeful sampling methods, was used as sampling method. This sampling method requires the identification of a typical situation from a large number of situations in the universe related to the research problem and the collection of information on the sample (Patton, 2014). On the other hand, BILMER Teacher Questionnaire was also announced to teachers online because teachers could organize a field trip to the science centers in the surrounding provinces even if there were no science centers in their provinces and to reach a sufficient number of participants primarily through the BILMER website (www.bilmer.gazi.edu.tr) and through the Ministry of National Education. Because of the participants who can be reached as a result of these interventions, another preferred method of sampling in the study is the convenient sampling. In this sampling method, the researcher wants to work on the most accessible and maximum sample until s/he reaches a group s/he needs (Büyüköztürk et al., 2014).

As a result of these sampling procedures, BILMER Teacher Questionnaire was completed by 439 teachers. Of the 439 teachers, 84 of them were determined that they are not in the branches of the project (English teacher, history teacher, Turkish teacher, etc.), which was not taken into the data analysis, and finally 355 teachers were included in the study. The demographic information of the teachers participating in the study is presented in the table below (Table 1).

The majority of the teachers who participated in the study (n=355) were 20 years old and over. The majority of teachers are graduates of the Faculty of Education (63.7%). Again, the majority of teachers work in public schools, but it is seen that they have a range of 1-20 years of professional experience (81%). It was observed that about half of them have done postgraduate studies (53.2%). In addition, n = 179 (50.4%) participants were from provinces with a science center and n = 176 (49.6%) participants were from other provinces in the study. Approximately 33% of teachers organized a field trip to science centers, while the majority did not. This table shows that the teachers participating in the research have quite different characteristics and experiences and the data are obtained from a diverse group of teachers.

Table 1. Frequency and Percentages of Demographic Features of the Teachers

	(f)	**(%)**
Gender		
Male	183	51.5
Female	172	48.5
Age		
20-39	228	64.2
40-59	126	35.5
60 and above	1	0.3
Education Level		
Bachelor's Degree	166	46.8
Graduate continues / Graduate	189	53.2
Graduate School		
Faculty of Education	226	63.7
Faculty of Science / Faculty of Arts and Sciences	123	34.6
Other	6	1.7
Type of school		
Public school	303	85.4
Private school	52	14.6
Branch		
Science (Science, Physics, Chemistry, Biology)	283	79.7
Mathematics	72	20.3
Work Year/Experience		
1st year-10 years	143	40.2
11-20 years	145	40.8
Over 20 years	67	18.9
Cities with Science Centers		
SC available	179	50.4
SC not available	176	49.6
Participants organize school trip to Science Center		
Yes	118	33.2
No	237	66.8
Total	355	100

Data Collection Tool and Data Analysis

In order to enable the science and mathematics teachers working in the secondary and high schools benefit from the opportunities of science centers in their classes more, the relevant field for determining the educational needs and the needs of the science center and outside of the school (Langreo, 2007; Şentürk, 2015) and also (OECD, 2010) has been examined in detail and a draft questionnaire consisting of 29 questions, including multiple choice, Likert type and open-ended questions, has been developed. In the first part of the teacher questionnaire, consisting of two parts, teachers' demographic characteristics (profile) and their professional development status and needs were asked, and in the second part, their opinions on trips to science centers and their professional development needs were questioned. The draft questionnaire was sent to five academicians from various universities who are experts in the field of survey development and feedbacks were received on the validity of the view and scope of the project. As a result of these feedbacks, the draft questionnaire was shared with a teacher who conducted class trips to science centers and the content of the questionnaire in the form of "necessary", "not required, because", "not understood/corrected" was discussed. At the last stage, a linguist examined the questionnaire in terms of compliance with the Turkish grammar rules. Feedbacks received after these corrections and questionnaire items have been revised, some questions have been edited, removed or added. Consequently, 24 questions were determined and BİLMER teacher questionnaire was finalized.

In the BILMER Questionnaire, which contains questions in different ways, the data of multiple choice questions containing opinions are given as frequency and percentage, while the data for likert type rating questions are analyzed by means of descriptive analysis by calculating mean, standard deviation, frequency and percentage. In some of the questions, if the participants selected the option "I have no idea" or "do not know", or left the relevant question blank (for example, Table 4 and Table 5), the answers of these participants were excluded from the data set and analyzed.

Results

In this section, the findings obtained from the BILMER Teacher Questionnaire are presented under three headings by discussing the data on the questions that show the status of the teachers regarding their professional development needs. First, teachers' opinions on professional development activities are presented. Then, the experiences of teachers about science centers and finally the findings related to the need for professional development in science centers are discussed.

Opinions of Teachers on Professional Development Activities

In BILMER Teacher Questionnaire, questions were asked about the participation status of the teachers in the professional development education, the reasons why the teacher can or cannot participate in the professional development education, the level of appreciation of professional development activities and the impact of the education they receive on their professional development.

The answers of the teachers to the question "in the last three years have you attended any professional development training?" are given in Table 2.

Table 2. Attendance of Teachers' Professional (in-service) Training Program in the Last Three Years

	(f)	**(%)**
Yes, I attended	259	73.0
No, I did not	96	27.0
Total	355	100

According to Table 2, the majority of teachers (n=259, 73.0%) in the last three years from professional development training/activities (course/workshop/seminar, etc.) are observed to participated in any one of them.

The answers of the teachers to the question "What is the most important reason why you can't participate in any professional development training/activity?" are given in Table 3.

Table 3. The Reasons Why Teachers Do Not Participate in Professional Development Training

	(f)	(%)
Professional development trainings / activities coincide with my working hours	75	26.3
There is no professional development program suitable for my needs	56	19.6
I don't have enough time because of my family responsibilities	39	13.7
Since my budget is not enough	25	8.8
I can't get enough support from the school administration (permission etc.)	20	7.0
Professional development trainings / activities are quite expensive	17	6.0
I did not benefit from the professional development activities I participated in before	14	4.9
Since professional development trainings / activities are not among my priorities	1	0.4

According to Table 3, teachers stated that they could not participate in any professional development training/activity, since the professional development trainings overlap with their working hours (26.3%), due to lack of a professional development program suitable for their needs (19.6%) and due to lack of adequate time due to family responsibilities (13.7%). Only one of the teachers who completed the survey stated that s/he did not prioritize these training as a reason of a lack of participation in professional development training.

In literature; It is emphasized that teachers feel that their self-efficacy increases and / or needs to be appreciated as they receive feedback from the people around them (European Commission, 2014). In this context, teachers' responses for the level of professional development education they receive and who is appraised and appreciated are given in Table 4.

Table 4. The Importance Given by The Stakeholders to The Professional Development Trainings of The Teachers

			No cares (1)		A little Caring (2)		Very Cared (3)		I don't know / No answer	
	X	SS	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
School Manager/Principle	2.07	0.75	63	24.7	111	43.5	81	31.8	100	28.2
Students	1.99	0.74	67	27.2	113	45.9	66	26.8	109	30.7
Colleagues	1.93	0.65	68	24.7	157	57.1	50	18.2	80	22.5
Educational Supervisors	1.79	0.74	60	39.5	64	42.1	28	18.4	203	57.2
Student Families	1.74	0.75	94	45.0	76	36.4	39	18.7	146	41.1

When the percentages in Table 4 are examined, when I don't know / No answer options are excluded, it is observed that the professional development education received by the teachers is evaluated as "very important" by other people in the range of 18.2% and 31.8%, in fact, with a low percentage. It is seen that the percentage of teachers is neglected by the relevant stakeholders is between 24.7% -45.0%. When the arithmetic means of the answers given by the teachers' views are considered, the professional development they receive is firstly considered by the school principals, and lastly by the families.

The answers given to the question of how effective the professional development activities of teachers are in the professional development are given in Table 5.

Table 5. The Effect of Teachers' Professional Development Training

			Not at all effective (1)		Less effective (2)		Moderately effective (3)		Very effective (4)		No idea/ No Answer	
	X	SS	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
Master education about teaching profession	3.54	0.80	6	4.3	9	6.4	29	20.7	96	68.6	215	60.6
Courses / seminars / workshops to improve PCK	3.36	0.86	8	3.8	30	14.2	50	23.7	123	59.3	144	40.6
Doctorate education about teaching profession	3.33	1.00	6	11.1	3	5.6	12	22.2	33	59.1	301	84.8
Courses / seminars / workshops to improve content knowledge	3.29	0.87	11	5.3	23	11.1	67	32.4	106	51.2	148	41.7
Symposium, conference and seminars on teaching & learning	3.29	0.78	4	1.8	33	14.7	82	36.6	105	46.9	131	36.9
To actively participate in social networks related to professional development of teachers	3.20	0.88	8	3.7	41	19.2	67	31.3	98	45.8	141	39.7
Participate in professional communication networks related to professional development of teachers	3.03	1.05	18	13.1	19	13.9	41	29.9	59	43.1	218	61.4

When the percentages of the answers given to the questions about which of the training examples that teachers participated in were effective in their professional development, if I have no idea / do not know responses are not taken into consideration and responses are examined according to the percentages of those who think that they are very effective, the first three most effective education are found to be (1) master education related to teacher profession (2) courses / seminars / workshops aimed at improving the knowledge in field; and (3) doctoral education related to the teaching profession.

Opinions and Experiences of Teachers about Science Centers

In this section, the findings were discussed related to the frequency of organizing school trip to the science center, the difficulties and obstacles they encountered while organizing trips to the science center, the educational value of trips and the reasons for arranging school trips to the SC as perceived by teachers.

In Table 6, the answers given by the teachers to the question "Are you organizing class trips to the science centers?".

Table 6. The Frequency and Percentage of School Trips to The Science Center of Teachers

	Teachers in cities with SC (n=179)		Teachers in cities without SC (n=176)		Total (n=355)	
	(f)	(%)	(f)	(%)	(f)	(%)
I arrange once a year	66	36.9	26	14.8	92	25.9
I arrange once a semester	14	7.8	2	1.1	16	4.5
I arrange more than two times a year.	8	4.5	2	1.1	10	2.8
Total (Field trip to SC)	*88*	*49.1*	*30*	*17.1*	*118*	*33.2*
I never do	91	50.9	146	82.9	237	66.8

Of the teachers participating in the study, 33.2% organized trips, 66.8% did not organize any trips, 25.9% held once a year, 4.5% held at least once every semester, and only 2.8% held class visits to more than two annually. Approximately half (49.1%) of teachers in provinces with science centers organized trips at least once, while 17.1% of teachers in provinces without science centers organized field trips to science centers.

When the reasons why teachers did not organize a trip to the science center were questioned; The frequency and percentages of teachers who have previously organized or not organized a trip are given in Table 7.

Tablo 7. The Difficulties and Challenges Teachers Face When Organizing Trips to The Science Center

	Teachers organizing a class trip (n=118)		**Teachers do not organize a class trip (n=237)**	
	(f)	**(%)**	**(f)**	**(%)**
Difficulties in obtaining the necessary permissions	80	67.8	156	65.8
Transportation fee	66	55.9	158	66.7
Lack of adequate time when considering school curricula or academic year	61	51.7	121	51.1
The curriculum is not compatible with this type of trip	56	47.5	77	32.5
The lack of noteworthy science centers which are not at the appropriate distance for a field trip	53	44.9	122	51.5
Teachers are not given a training on how to do a field trip to the science center	52	44.1	126	53.2
Inadequacy of support provided by the school administration	45	38.1	92	38.8
Teacher's attitude / unwillingness	40	33.9	66	27.8
Disciplinary problems / behavior problems of students	38	32.2	75	31.6
Create extra workload	35	29.7	60	25.3
Entrance fee to SC	33	28.0	81	34.2
Teachers' lack of self-confidence in organizing class trips to the SC	23	19.5	35	14.8

Similar results were generally obtained when examining the most important difficulties and barriers faced by teachers who organize or does not organize a field trip to a science center. The main problems faced by teachers in both groups of participants are the difficulties in obtaining the necessary permits and transportation fees. Considering the school curriculum or the school year, the main problems of teachers *organizing trips* to the science center are inability to create appropriate time (51.7%), that the curriculum is not compatible with this type of trip (47.5%) and that noteworthy science centers are not at the appropriate distance for a field trip (44.9%). Teachers were not given any training on how to make a field trip to the science center (53.2%), %), noteworthy science centers are not at the appropriate distance for a field trip (51.5%) and the lack of appropriate time considering the school curriculum or academic year (51.1%) are the other important problems of teachers who *do not organize trips*. In both groups, teachers' lack of self-confidence in organizing a trip to the science center was the least major problem.

It can be said that the teachers have a common view that their field visits to science centers are valuable in terms of education. When the teachers who organize (n = 118) a field trip were asked to evaluate their trips to the science centers in terms of their benefits, the majority of the teachers stated that these trips were very valuable or above average (65.2%) in terms of education. When the teachers (n = 237) who did not organize a field trip were asked to evaluate their class trips to the science centers in terms of their benefits, the majority of the teachers stated that these trips were very valuable or above average (76.7%) in terms of education (Table 8). In other words, teachers in both groups stated that despite all difficulties and obstacles, the educational value of science centers is high.

Table 8. The Educational Value of Trips to The Science Center from The Perspective of The Teachers

	Teachers organizing a trip (n=118)		Teachers do not organize a trip (n=237)	
	(f)	(%)	(f)	(%)
Very high	41	34.7	107	45.1
A little above the middle	36	30.5	75	31.6
Middle	35	29.7	44	18.6
A little under the middle	5	4.2	4	1.7
Very low	1	0.8	7	3.0

Finally, the teachers were asked about the reasons for organizing a field trip to science center regarding their views and experiences about science centers. The frequencies and percentages according to the teachers organizing and not organizing trips are given in Table 9.

Table 9. The Reasons of Teachers Organize A Class Trip To Science Center

	Teachers organizing a trip (n=118)		Teachers do not organize a trip (n=237)	
	(f)	(%)	(f)	(%)
To develop students' positive attitudes and increase their interest towards science	102	86.4	215	90.7
To give the opportunity for students to show how the concepts they learn in the classroom are used in real life	89	75.4	185	78.1
An environment where my students can actively participate in the activities	85	72.0	154	65.0
Students are given the opportunity to play a real scientific instrument / model	84	71.2	154	65.0
To ensure that my students are aware of developments in science and technology	52	44.1	130	54.9
An environment with materials and exhibitions to help students understand subjects in the classroom	49	41.5	99	41.8
Students are given the opportunity to take them out of school	35	29.7	50	21.1
It allows me to build a better teacher-student relationship with my students	33	28.0	59	24.9
Science center experience keeps my students more interested in curriculum issues	31	26.3	59	24.9
There is no laboratory possibility in the school	23	19.5	57	24.1
Compulsion/obligation (due to factors such as school management, parent, etc.)	8	6.8	22	9.3

According to Table 9, teachers who organize class trips (n = 118) and teachers who do not organize class trips (n = 237), the five most important reasons for organizing class trips are (1) to develop positive attitudes and interest of students towards science, (2) to provide students with the opportunity to demonstrate how the subjects they have learned in the classroom are used in real life in the science center, (3) science centers are an environment where students can actively participate in activities, (4) to give students the opportunity to play with real scientific instruments / models in science centers and (5) to make students aware of developments in science and technology. The teachers in both groups saw that they did not do these field trips because of necessity as a last reason.

Teachers Professional Development Needs for Learning in Science Centers

This section aims to reveal the professional development needs of teachers in science centers; the content of the professional development programs that the teachers participated before, the

frequency of the activities aimed at some related learning achievements in the education programs in the science centers, the need for professional development education for science centers and the need for in-service training courses supported by the Ministry of National Education (MONE), the analysis of the answers to the questionnaire questions were investigated.

Firstly, the teacher's responses to the question of which of the science centers they received a professional development training to improve their knowledge and skills were analyzed. Results are given in Table 10.

Table 10. The Content of The Professional Development Programs That Teachers Participated Before

	I got training.		**I didn't get training.**	
	(f)	**(%)**	**(f)**	**(%)**
A professional development training for science centers	86	24.2	269	75.8
What is science? The nature of science and science teaching	38	10.7	317	89.3
Scientific content related to the exhibition / workshop in science centers	34	9.6	321	90.4
The importance and design of science festivals and workshops	31	8.7	324	91.3
Development and implementation of the versions of the science center exhibits that can be used in class	26	7.3	329	92.7
Developing and implementing lesson plans for learning in science centers	24	6.8	331	93.2
Learning theories, teaching strategies and applications in out-of-school settings such as science centers	21	5.9	334	94.1
Science-society communication and its importance	20	5.6	335	94.4
Discourse analysis	4	1.1	351	98.9

Only 24.2% of the teachers have been observed to receive some training when asked whether they have received any professional development training related to the knowledge and skills in relation to science center directly in their professional life (Table 10). However, the questionnaire also questions whether teachers receive professional development in relation to the content that should be involved in a professional development in relation to learning in science centers. In the in-service programs attended by teachers, the first three subjects; What is science, nature of science and science teaching (10.7%), scientific content related to exhibition / workshop in science centers (9.6%), and the importance and design of science festivals and workshops (8.7%).

The results of teachers' opinions on the frequency of the activities that aim to achieve some learning outcomes in the curriculum are presented in Table 11.

Table 11. Teachers' Opinions About The Frequency of Activities in Science Centers Aimed at Learning Outcomes

	(f)	**(%)**
Often	173	48.7
Sometimes	97	27.3
Always	69	19.4
Rarely	13	3.7
Never	3	0.8

According to Table 11, approximately half of the teachers (n=173, 48.7%) thought that the teaching activities aiming some related learning outcomes in the curriculum should be done frequently, while 97 teachers (27.3%) thought that those activities should be done occasionally, 69 of the teachers (19.4%) stated that they should always do this, and 13 teachers (3.7%) rarely mentioned those activities and 3 teachers (0.8%) stated that those activities should not be done at all.

Additionally, in the questionnaire used in the study, the teachers were also given ideas about the professional development education topics they needed to make more efficient use of the opportunities in science centers in their teaching. Findings on teacher opinions are presented in Table 12.

Table 12. Professional Development Training Needs of Teachers About Science Centers

			I don't need (1)		I need some (2)		I really need (3)	
	X	**SS**	**(f)**	**(%)**	**(f)**	**(%)**	**(f)**	**(%)**
Knowledge of development and application of lesson plans that integrate the opportunities in science centers into curriculum	2.67	0.53	11	3.1	96	27.0	248	69.9
In the framework of the school-science center cooperation, the knowledge that teachers will work efficiently and harmoniously with the science centers' explainers.	2.64	0.56	14	3.9	100	28.2	241	67.9
The knowledge of examples and application of various teaching strategies related to learning process in science centers	2.59	0.56	12	3.4	122	34.4	221	62.3
Information about out-of-school learning environments such as science centers	2.52	0.60	20	5.6	131	36.9	202	56.9
The approach and application knowledge about students' understanding of what science is, developing attitudes towards science and scientific thinking skills	2.51	0.61	22	6.2	131	36.9	202	56.9

According to table 12, the first three of the professional development education subjects that teachers need most are (1) knowledge of development and application of lesson plans (n=248, 69.9%) that will enable the facilities in science centers to be integrated into teaching programs, (2) in the framework of the school-science center cooperation, teachers knowledge of how to work efficiently and harmoniously with instructors (n=241, 67.9%) and (3) examples and application of knowledge on various teaching strategies related to the learning process in science centers (n=221, 62.3%).

In the questionnaire, another question asked in parallel with teachers' needs for science centers is about teachers' opinions on the provision of in-service training courses with MNE to teachers so that teachers can benefit more from the opportunities of science centers. The results of the teachers' responses to this question are given in Table 13.

Table 13. The Teachers' Demand for MNE Supported in-service Training Courses About Science Centers

	(f)	**(%)**
Absolutely	226	63.7
Must be	88	24.8
Should never	18	5.1
Undecided	17	4.8
Not to be	6	1.7

As can be seen from the data in Table 13, the majority of teachers who have expressed their views on "definitely presented" and "must be presented" for in-service courses related to science centers in relation to their professional developmental needs are the majority (n=314, 88.5%).

Discussion

In using science centers as a learning-teaching context, it is vital that teachers carefully plan field trips and activities according to the objectives that they aim to achieve for their students (Morentin & Guisasola, 2015). On the other hand, although it is accepted that the use of science centers in science teaching has strengths, it is emphasized that it is not easy to increase the awareness of prospective teachers (Chin, 2004) and teachers about how to learn in such different learning environments with traditional teaching programs and techniques (Tal et al., 2005). From this point of view, teachers' needs, thoughts and roles that they perceive themselves are important in determining the content of these professional development programs (Clarke-Vivier & Lee, 2018; Tal & Steiner, 2006). In light of these reasons, ,in this study; in accordance with the answers of 355 teachers from science and mathematics fields who have been working in the state or private schools in the 66 different provinces of Turkey, especially the ones which contain science centers (n=18), (1) the teachers' experience, age, education status, gender (2) the experiences of the teachers on the science centers and (3) their needs related to the professional development programs to be organized in order to benefit from the opportunities of those centers for the education were determined by means of the questions of BILMER Teacher Questionnaire developed for the first time for contributing to national field literature with a wide and heterogeneous participation. The findings obtained in accordance with teachers' responses provide important information to make effective use of Science Education from science centers. Those results shed light on the basic characteristics of a qualified professional development program to be developed in science centers.

In recent years, the importance of 'Teachers Professional Development' programs aiming to improve teachers' skills in different areas is increasing day by day (Garet et al., 2001; NRC, 2009; National Science Teachers Association [NSTA], 1998). This is because it is emphasized in the relevant literature that the teachers should be provided opportunities for them to comprehend the scientific information which changes and improves fast and they also should participate in the opportunities they are provided (Melber & Cox-Petersen, 2005). In this context, when the teachers' responses to the question "have you attended any professional development training in the last three years?" are examined, the majority (73.0%) of them, in the last three years at least has participated in any of the professional development education/activities (courses/workshops/ seminars, etc.) (Table 2). On the other hand, the teachers pointed out that the obstacles for them to participate in any professional development training/activity are the coincidence with working hours, lack of a suitable professional development program and lack of sufficient time for family responsibilities constitute (Table 3). In addition, teachers' opinions will give an idea to the relevant stakeholders in terms of the main variables in the process of organizing professional development programs in our country. The fact that there are teachers who cannot attend the training because they cannot find professional development programs suitable for their needs indicates that the needs of teachers are not taken into consideration in the trainings given in Turkey. This finding supports the importance of the need analysis approach in this study before determining what should be done in a professional development model to be developed for teachers.

A sense of appreciation by others (stakeholders) has a positive effect on Teachers Job Satisfaction and teaching practices. According to the findings of this study, the percentage of the professional development trainings that they participated in was sufficiently cared for by the school principal, students, colleagues, inspectors and student families ranged from 18.2% to 31.8% (Table 4). Unfortunately, one finding that should not be ignored is that almost half of the teachers (7.9%) think that their participation in professional development training is not particularly considered by the student families. Because in the studies carried out in the field, it is emphasized that teachers need to get feedback from the people around them and/or should be appreciated in order to increase their self-sufficiency (European Commission, 2014).

The purpose, characteristics, and quality of professional development programs offered to teachers have different effects on them (Neathery, 1998). In this context, when we examine the answers to the question of which teachers participate in the training and how effective they are in their professional development, and the first three most effective training activities are taken into consideration; it is observed that the responses are courses/seminars/workshops for teacher training, participation of teachers in professional communication networks related to professional development, and development of field/field education knowledge (Table 5). Those results are similar to the findings of studies in the literature, which emphasizes the importance of teaching field knowledge (both scientific content and pedagogical field knowledge), which are components of professional development programs that positively affect teachers' knowledge-skills and classroom performance (Garet et al., 2001).

Although the US National Research Council's reports in 1996 and 2000 suggest that class trips can be used as a way of teaching research, inquiry, and science (NRC, 1996, 2000); today class trips are still not considered as a learning experience (DeWitt & Storksdieck, 2008). As a matter of fact, it was found that more than half of the teachers (66.8%) had no excursions, and only a small number of teachers (33.2%) had visited a science center at least once. When we questioned why teachers does not organize visit the science centers in Turkey, based on the findings in Table 7, similar results about the most important difficulties and barriers faced by teachers were generally obtained according to teachers who organize or does not organize a field trip to a science center. The two main problems faced by teachers in both groups of participants are the difficulties in obtaining the necessary permits and the transportation fee. The third main problem of the teachers who organize the trip is the lack of time considering the curriculum or the academic year, whereas the third reason indicated by the teachers who do not organize a trip to the science center is not taking any education about how to make a class trip to the science center. These results also show parallelism with the study by Morentin and Guisasola (2015), where teachers have to deal with financial pressures, time constraints and the obligation to train curricula, which significantly limits their willingness to do field trips. Despite all difficulties and limited opportunities, the vast majority of teachers in our country - even teachers who do not even organize trips - are of the opinion that class trips to science centers are high and above average in terms of education (Table 8). The teachers, who think that the value of science centers in terms of education are important, also emphasized that science centers are very important in developing positive attitudes towards science and increasing students' interest by actively participating in teaching the subjects they have learned in class and in showing how they are used in real life and allowing them to play with scientific instruments/models to the truth (Table 9).

In recent years, out-of-school learning environments, such as science centers, are not seen as an alternative to school learning, but as a tool that should be integrated into school curricula. Braund and Reiss (2006) claimed that that the participation in classroom activities could be increased by associating the science presented in out of school learning such as the science museums, science centers, historical museums, natural museums, etc. with what is presented in the school. In Turkey, it is stated that this type of out-of-school learning environment has just been introduced (Taşdemir, Kartal, & Özdemir, 2013). On the other hand, according to the findings obtained as a result of this study, it is observed that the majority of the teachers in Turkey have not received professional development education – which will support almost all of them to benefit from the educational activities of the science center efficiently (Table 10). For example, it is an interesting conclusion that 75.8% of the teachers have not received training on how to make a field trip to science center and 93.2% have not received training on developing and implementing lesson plan related to learning in science centers. However, when Table 11 is examined, 68.1% of the teachers expressed their opinions indicating that teaching activities aiming some learning outcomes should be carried out in the science center programs frequently and at all times. In the relevant literature, it is stated that the reason teachers are not able to make use of science centers in their classrooms (Griffin & Symington, 1997; Ramey-Gassert et al., 1994; Tal et al., 2005) is that teachers were not offered any professional training on how to make use of out of school learning environments (Melber & Cox-Petersen, 2005). Moreover, most teachers have very few opportunities to

engage in learning experiences in outside the classroom during their undergraduate education, as a result, they do not have pedagogical knowledge of how science centers can effectively be used in teaching by associating opportunities with the curriculum (Morentin & Guisasola, 2015).

Although the literature on science education in out-of-school learning generally focuses on parents, students and adult visitors (Ash, 2003; Borun, Chambers, & Cleghorn, 1996; Cox-Petersen et al., 2003; Falk & Dierking, 1997; Griffin & Symington, 1997; Melber, 2003), some professional development programs are also offered for teachers in many out-of-school learning environments (e.g. Exploratorium, San Francisco Museum; Boston Science Museum, Denver Natural History Museum). In 2013, it was emphasized by Angadi that in determining the content of those professional development programs, firstly a need analysis of teachers' requirements should be carried out and the necessary professional support should be provided by taking into consideration the school environments in which the teachers are working (Angadi, 2013) according to the results of those studies. In this study, it was determined that one of the most important reasons for teachers not to participate in professional development training was the lack of in-service courses for their professional needs (Table 3). On the other hand, when the need for professional development training for science centers is questioned (Table 12), teachers have expressed their opinions on i) the need for the development and application of lesson plans that integrate the opportunities in science centers into curriculum, ii) how teachers can work efficiently and harmoniously with Science Center trainers, and iii) the need for examples and application information on various teaching strategies related to the learning process in science centers (over 60%).

Conclusion

The educational values of science centers, exhibitions at the Science Center, workshops, science shows, etc. depend on the degree of preparation made by the teachers before they see the activities (Cox-Petersen & Pfaffinger, 1998). In case those preparations can be associated with the curriculum, the increase on the students' participation in classroom activities and on their attitudes for science is observed (Braund & Reiss, 2006). By considering all of the abovementioned issues, it can be said with no doubt that the most important task is to make effective use of the opportunities of science centers in teaching in schools. On the other hand, if there is no effective professional development related to out-of-school learning environments such as science centers, it is impossible for teachers to realize the educational importance of the opportunities in science centers and make use of them in their classrooms (Melber & Cox-Petersen, 2005). At this point, it should not be forgotten that teachers should be aware of how they can benefit from science centers and they should be subjected to professional development training related to learning (Cox-Petersen et al., 2003; Melber & Cox-Petersen, 2005).

In addition to the different emphases and contents within the literature related to the contents of those professional development programs (field knowledge, pedagogical field knowledge, developing sample applications in class, how to organize a successful class trip, etc.) (Birman, Desimone, Garet, & Porter, 2000; Garet et al., 2001; McLeod & Kilpatrick, 2001; NRC, 1996; Loucks-Horsley, Hewson, Love, & Stiles, 1998; McLeod & Kilpatrick, 2001; Smith, McLaughlin, & Tunnicliffe, 1998), the most important issue may be the consideration of the needs of the teachers for their professional development (Angadi, 2013). In this study, it was concluded that despite the difficulties experienced by teachers in Turkey, they are aware of the high educational value of the activities organized in science centers and they demand the provision of in-service training activities for those centers. Based on the findings of this study, it was determined that the teachers prioritize the issues that should be included in the professional development package, one of which is to make more efficient use of the opportunities in science centers: (i) the development and application of lesson plans that integrate the opportunities in science centers into curriculum, (ii) knowledge of how teachers will work efficiently and harmoniously with explainers of science centers within the framework of school-science center cooperation and (iii) examples and application of various instructional strategies related to the learning process in science centers.

Suggestions

The science centers are aimed to be spread to 81 provinces of Turkey within the scope of the project "Target is 2023" by the Ministry of Science, Industry and Technology. As a natural consequence of it, the necessity of investing in this direction has gained prominence through this research, which will constitute the basic interface of communication between science centers and students today and in the future. The fact that many teachers in Turkey has graduated without being aware of the science centers and they even have not known how to organize a successful class trip to science center supports that claim (Taşdemir et al., 2013). Unfortunately, the teacher trainings offered at universities cannot provide teachers with all of the competencies they need during their careers. Therefore, in-service professional development is essential and professional development training should be organized to help teachers develop their practice continuously (European Commission, 2014). In doing so, teachers' needs should be taken into account.

Considering the results of this research, it is thought that the most important way to spend an important resource and make effective use of the community from the science centers where the investment is made is to provide professional training to teachers in this field. For this purpose, scientific research need to be emphasized on the development of teachers' professional development programs which take into account the needs of the teachers in Turkey. In line with the results of this research, the following suggestions may be presented:

- First of all, all teacher candidates must take a specific number of courses which will contain several contents related to the out-of-school learning environments.
- Regarding the teacher training policies, bureaucratic arrangements should be designed and put into practice to lead up the teachers from benefiting from science center efficiently and to eliminate the difficulties they face.
- By encouraging the teachers to develop curriculum-compatible course plans before, during and after their class trips. (DeWitt & Osborne, 2007), the interests and needs of the teachers revealed by this research or by the similar researches should be considered in the professional development programs to be presented. Professional development programs for science centers in Turkey should contain the following: (i) the development and application of lesson plans that integrate the opportunities in science centers into curriculum, (ii) information on how teachers will work efficiently and harmoniously with explainers of science centers within the framework of school-science center cooperation and (iii) some examples and information on practice of the several teaching strategies related to the learning processes in the science centers. Teachers' professional development programs should contain both theoretical and practical applications (Joyce & Showers, 1995), and the constructivist learning approaches should be taken into consideration in those applications (Adey et al., 2004; Holliday et al., 2013). Teachers' education should be constructivist because it is an open-ended process where the teacher acquires ideas, understand them and situate them in his/her context. This could be possible only when theory and action were taken simultaneously and constructed in teachers' mind (Keiny, 1994). Although teachers generally prefer less content for theoretical presentations in professional education, they should participate in practical activities involving theoretical approaches to learning in science centers. In-service training programs for teachers about learning in science centers should include at least 30 hours of theoretical and practical training as mentioned in the literature for effective professional development programs (Guskey & Yoon, 2009; Lauera, Christopherb, Firpo-Triplettb, & Buchtingb, 2014) and they should be operated interactively with the explainers of the Science Center particularly in the centers (Kanlı, Yanış, & Köseoğlu, 2019; Köseoğlu, Kanlı, Özdem Yılmaz, & Çiğdemoğlu, 2018).

- In order to benefit from science center facilities, teachers should be offered in-service training courses certified by public institutions such as Ministry of National Education (MONE), Turkish Academy of Sciences (TÜBA), universities and science centers.

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