Conducting science fair activities: Reflections of the prospective science teachers on their expectations, opinions, and suggestions regarding science fairs1

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Contents

Abstract

The aim of this study is to examine the reflections of the prospective science teachers on their expectations, opinions, and suggestions towards science fairs. The study was conducted with 34 prospective science teachers. All participants had education in junior class of Science Teaching Program of a university located in western part of Turkey in the spring term in 2013-2014 academic year. The prospective science teachers were taking a Community Service course during the study. The study was qualitative in nature. More specifically, it was a phenomenological study. The data included pre-written and post-written interviews with all participants as well as face-to-face interviews with 12 selected prospective science teachers. The content analysis results revealed the expectations of the prospective science teachers towards science fair, difficulties and outcomes of the science fair practice, and suggestions related to instructional plans and improvement of the implementation. At the end of the study, it is believed that providing prospective teachers opportunities to develop their instructional skills in a community of practice situated in authentic activities may help them learn to teach more effectively and gain broader perspectives. Moreover, creating such opportunities for students in schools through cooperation with universities might be fruitful both for prospective teachers and students in terms of supporting science education.

Keywords: Content analysis, prospective science teachers, science fair activity, situated learning

Introduction

Science fairs have been accepted as in-school activities for long years (Dionne, Reis, Trudel, Guillet, Kleine, & Hancianu, 2012) as they might provide appropriate environments for students to create their own study questions, develop methods to find solutions to these questions, and discuss findings in order to increase their curiosity towards science (Chen, Lin, Hsu, & Lee, 2011). The calls of Framework for K-12 Science Education (National Research Council [NRC], 2012) and the Next Generation Science Standards (NGSS Lead States, 2013) for developing the skills of students to design scientific experiments, and to carry out and to examine experiments draw attention to the necessity of creating effective science fair environments. National Science Teachers Association (NSTA, 1990) also states that well-organized science fairs transform project development and research process into a learning experience and these kinds of experiences increase the interest in science (as cited in Blenis, 2000).

Through creating opportunities for students to share their research with their friends, teachers, and scientists, science fairs provide students with the opportunity to form new information and to increase their interest in scientific activities. Then, they develop their scientific process, inquiry, and communicative skills, and get prepared for their future professional life (Abenarty & Vineyard, 2001; Schmidt, 2014). For instance, Finnerty (2013) conducted a study on the views of teachers in order to examine the possible advantages of participating in science fairs for secondary school students. As a result, the participating teachers stated that students had deeper comprehension about science, that their inquiry skills were developed, and their interest in science and career in science was increased.

Science fair opportunities for prospective teachers also have definite advantages. The literature suggests that informal science environments are useful resources in teacher preparation (see Avraamidou, 2014). In a study by Avraamidou (2015) on prospective teachers' views about the role of informal science environments (including science fairs) in science teaching and learning, it was suggested that prospective teachers positively perceived such environments. The participants pointed that through engaging in science fairs, they developed ownership of their learning as well as content knowledge, and they also had fun. Accordingly, engaging in well-designed informal science approaches can help prospective teachers better understand the value of science and science teaching. Then, creating environments that gather teacher educators, teachers, prospective teachers, and students is considered as one of the options to develop the interest and motivation of prospective teachers towards science teaching and increasing student interest in science.

Theoretical framework

Situated perspective of learning theory developed by Lave and Wenger (1991) suggests that participation and interaction in a community of practice situated in authentic activities may bring learning (Borko et al., 2007; Lave & Wenger, 1991). Accordingly, learning is a function of context and activity. Through social participation and relationships called legitimate peripheral participation, learners move from the periphery to the centre of the community where learning occurs (Lave & Wenger, 1991; Smith, 1999). Situated perspective is believed to help teachers gaining cognitive flexibility which help them develop adaptation skills to transfer their knowledge to changing situations (Shulman, J., 1992) which brings about learning (Lundeberg et al., 1999). Then, providing teachers/prospective teachers opportunities to develop instructional skills in a community of practice situated in authentic activities may help them learn to teach more effectively and gain broader perspectives. At this point, science fair activities might be one of the alternatives.

The importance and aim of the study

Science fairs are common practices in European countries and its popularity is increasing in other regions (Bultitude, McDonald, & Custead, 2011). Even though their use is increasing currently in our country, the absence of sufficient studies regarding the effect of science fairs on PSTs is observed. Thus, it was thought that science fairs should be organized in Turkey even on a small scale which may attract teachers and students. This would encourage researchers, educators, and/or teachers to organize science fairs at advanced levels. Apart from teaching activities suggested in curricula, science fair practices may show the relationship between science and daily life, make crucial contributions to the science education of both prospective teachers and students, and reinforce their interests and motivations.

Moreover, in this study, while the literature suggests that informal science environments –including science fairs- are useful resources in teacher preparation (Avraamidou, 2014), it was aimed to determine PSTs' opinions and suggestions regarding science fairs, because it was thought that understanding PSTs' expectations, opinions, difficulties, and suggestions regarding science fair could bring about new alternatives to develop more effective activities for teacher preparation. It is believed that taking PSTs' opinions about their difficulties and their suggestions regarding science fair practices into consideration would be useful while preparing seminars on science fair practices within the scope of teacher training programs.

In core of this discussion, the present study aims to determine the expectations and opinions of PSTs as well as their suggestions regarding science fair practices. Therefore, the present study attempts to find answer to the question, "What are the expectations, opinions, and suggestions of PSTs regarding science fair practices?".

Methods

This study was qualitative in nature. More specifically, it was a phenomenological study. As in the present study and in phenomenological studies, the aim is to understand the shared meaning of a phenomenon for several participants as well as to determine their common aspects (Creswell, 2007).

In the part below, information about the participants, implementation process, and data collection and data analysis processes are explained.

Participants

The study included 34 PSTs enrolled in junior class of Science Teaching Program of a university located in western part of Turkey. The PSTs were taking Community Service course during the study. The study was conducted in the spring term of the 2013-2014 academic year. Demographic information on the participants is provided in Table I.

Table I. Demographic information

Participants	*#*	*Age*	*Grade*	*Gender*
PSTs	34	20-22	3rd	27 female / 7 male

The process and data collection

Throughout the study within the scope of Community Service course which takes a term to complete (14 weeks), science fairs were planned to be conducted with the consensus of 34 PSTs. Community Service course is a compulsory course in teaching programs of faculties of education, and one of its aims is to prepare and conduct voluntary projects in schools to gain social responsibility, and develop knowledge and skills regarding implementing services and communication. This course is generally conducted with groups of 8-10 prospective teachers under the responsibility of a faculty member. In this study, the researchers were the instructors of this course and in the scope of the course, conducting science fair activities in secondary schools was planned with PSTs in order to create an environment in which they develop social responsibility, communicate with students, and develop students' and their own knowledge of and interest in science.

The implementation process of the study, and data collection tools are explained below.

Choosing schools and students

In the process of choosing the schools where science fairs were carried out, the schools from districts in city centre with relatively low and medium socio-economical levels according to the Provincial Directorate for National Education (PDNE) were chosen in order to especially reach socio-economically disadvantaged students. According to the observations of the researchers, these schools either had no science labs or did not use them effectively. The researchers, primarily, interviewed with the heads of the schools, and after receiving consent, the study was carried out with groups of 3-4 students. Science fair activities were separately conducted in 4 different secondary schools with 4 different PST groups consisting of 8-9 persons each.

Participant students in science fair practices were chosen by their own teachers without any involvement of the researchers. The teachers either included student volunteers or chose the successful and interested students in science class.

Applying pre-written interviews

Before science fairs, pre-written interview reports were collected from all PSTs in order to understand their expectations and opinions related to science fair activities. The report consisted of 8 open-ended questions prepared by the researchers. In this interview, the PSTs were asked to answer questions related to their expectations, their previous experiences, their self-esteem regarding the implementation process, their views on the abilities of the participant students, and the expected difficulties etc.

Choosing experiments

In this process, PSTs primarily made presentations in the schools regarding their previous science fairs experiences. In this stage, the PSTs asked the participant students to suggest experiments to conduct in the science fairs in their schools. If students' suggested experiments were not accepted (since either they were not sufficient or not appropriate for the level, required too much time, were too costly, or impossible to carry out), the PSTs shared their own experiment suggestions with the researchers and the teachers. At the end, the experiments were chosen with consensus (i.e. acid and base in materials; non-Newtonian flow; paper chromatography; properties of dry ice; making a parachute; hand warmer; extracting DNA from banana; elephant's toothpaste).

Guiding prospective teachers and students

PSTs tested the experiments in the laboratory of the faculty with the researchers. Academic and pedagogical guidance were provided to PSTs in all stages. Then each PST provided guidance and support to a student group consisting of 3-4 students before science fairs. This guidance continued until participating students expressed that they gained self-confidence for the activities they would present in science fairs (which took approximately 2-3 weeks). Science fair preparation practices were carried out after lesson hours with the consent of parents and the heads of the schools. The PSTs also asked the participant students to prepare posters about their experiments.

Science fair activities

The activities presented during the science fairs were consisted of demonstration experiments as well as hands-on experiments. As a separate activity for each school, science fairs were conducted as a one-day event. Primary and secondary school students from neighbouring districts also participated in the activities as visitors. During the day of activities, posters were presented behind each experiment stand, and the experiments were repeatedly conducted for each visitor group by participant students guided by the responsible PSTs. The researchers of the study were present as observers in all science fairs.

Applying post-written interviews

After science fair practices, reports were collected through final written-interviews from the PSTs. Furthermore, face-to-face semi-structured interviews were conducted with 12 voluntary PSTs (almost 40% of the PSTs) using the same open-ended questions in order to get greater insight on PSTs' views on the experience. These interviews were also video-recorded with the permission of PSTs. The interview questions were related to whether their expectations were met after the activity, their ideas on the outcomes of the activity, participants' and their own difficulties, their ideas on the participant students' performance, their future instructional plans after the activity, and their suggestions related to the science fair activities etc.

Data analysis

For data analysis, the video records of interviews were primarily transcribed. Content analysis method was used both in the analysis of written and face-to-face interviews (Yildirim & Simsek, 2008). In this stage, three copies of written interview reports were independently coded by the researchers. After discussing the primary codes, common codes were determined. After coding the data set through using these codes, data were jointly evaluated, and final evaluations were made according to joint decision. Final codes were gathered under 5 themes explained below.

Expectations towards science fair practices

Two main codes were determined regarding this theme; affective and cognitive expectations. Affective expectations included 4 sub-codes as communication opportunity, getting attention/arousing curiosity/endearing, developing self-confidence, and enjoyable learning; and cognitive expectations included a sub-code gaining experience/developing knowledge-skill. PSTs evaluated the affective and cognitive expectations towards practices both for themselves and students.

The outcomes of science fair practices

Two main codes regarding the views of PSTs about the outcomes of science fair practices were affective and cognitive outcomes. Affective outcomes included 5 sub-codes as *communication opportunity, getting attention/arousing curiosity/endearing, developing self-confidence*, *enjoyable learning,* and *cooperation*. Cognitive outcomes included 2 sub-codes as *gaining experience/developing knowledge-skill,* and *connecting science with daily life and other issues*. Again, PSTs separately evaluated the outcomes for themselves and students.

The difficulties related to science fair practices

The challenges PSTs expected to encounter and they actually encountered during practices were gathered under 6 sub-codes as using chemicals, the process of conducting and explaining experiments, management, getting attention, communication, and using materials (manual skill). The ones stating to have no challenge were coded as having no challenge. PSTs evaluated the challenges again both for themselves and students.

Instructional plans

In the category of instructional plans to be applied by PSTs in their future teaching career, 2 codes deducted from their reports were experiment/activity based teaching, and using materials.

Suggestions for the development of science fair practices

The suggestions of PSTs for science fair practices included 3 sub-codes as *the number of participants, choosing experiment (appropriateness for the level of students, safety, being attractive/visuality, the number/type of experiment),* and*duration/frequency of practices*.

Direct quotations were provided in order to increase the reliability of the findings. The real names of the PSTs were not used, instead numbering was employed as PI-# for pre-interviews and FI-# for final interviews.

Results

Results regarding the themes and sub-codes are presented below.

Expectations towards and the outcomes of science fair practices

The expectations of PSTs before the practice, and their views regarding science fair after the practice were examined.

Table II. Prospective science teachers' expectations towards the science fair and their opinions on the outcomes

Codes	*Expectations*				*Outcomes*			
	PSTs		*Students*		*PSTs*		*Students*	
	%	*f*	*%*	*f*	*%*	*f*	*%*	*f*

Affective expectations and outcomes								
Communication opportunity	54%	22	3%	1	87%	42	23%	9
Getting attention/arousing curiosity/endearing	23%	11	83%	34	17%	5	93%	55
Developing self-confidence	20%	6	47%	18	60%	23	53%	26
Enjoyable learning	27%	9	30%	10	17%	5	33%	11
Cooperation	---	---	---	---	3%	1	33%	13
Cognitive expectations and outcomes								
Gaining experience/developing knowledge-skill	93%	37	50%	16	90%	41	57%	23
Connecting science with daily life and other issues	---	---	---	---	0%	0	27%	9

Affective and cognitive expectations of PSTs, and their views regarding affective and cognitive outcomes are as follows:

Affective and cognitive expectations regarding science fair practices

As seen in Table II, given the affective expectations of PSTs regarding the practice, PSTs were observed to share expectations regarding science fair practices at high level as getting the attention of students, making them love science and arousing their scientific interest (83%). The views of two PSTs were as follows:

> It helps students love science and technology better. It makes them love their school. They conduct experiments enabling them to learn through entertaining, and they enjoy it. Such practices are as beneficial for visitor students as the participating ones. They love science and technology, and they entertain. (PI-11)
>
> An entertaining learning environment that attracts students can be created thanks to science fairs. (PI-24)

PSTs also stated that science fairs would enable them to establish communication with students (54%). To give an example, one of the PSTs (PI-15) shared her expectations as:

> It will help me more accurately and more easily communicate with the students.

Similarly, 47% of PSTs shared their expectations of developing self-confidence in students. PST (PI-15) stated that:

> It will help students increase their self-confidence. Teaching an experiment to their friends will make them happy. Therefore, they will be more interested in science.

While 30% of PSTs expressed that students should enjoy learning, 27% stated their expectations towards creating an environment where students enjoyed learning. 23% of PSTs shared their expectation regarding the increase in their own interest, curiosity and love for science. Additionally, some of PSTs (20%) stated that their own self-confidence would develop through science fairs. For example, PSTs shared that:

> Thanks to this activity, I think I will be more self-confident and experienced. It will develop my responsibility and creativity. The more it contributes me, the more I will contribute to my students. (PI-25)
>
> Spending time with students will be good for me. My experience will increase and I will be more practical. In fact, I become anxious when I'm left alone with students since I've no self-confidence. I think I will overcome this through this activity. (PI-30)

Related to the cognitive expectations of PSTs regarding science fair practices, the majority of PSTs shared their expectations to have experience and develop their own skills regarding science fair practices (93%). For instance, PST-12 shared that:

> I think I can develop myself, try to guide students and research more subjects and explain those to them by simplifying to their level. I'm making preliminary preparation through searching internet, books, and of course with the help of you, my professors. (PI-12)

50% of PSTs also expressed that science fair practices might enable school students to develop knowledge and skills of science. For instance:

> I think such activity will develop the responsibility of students, create an opportunity for them to overcome their excitement of explaining and

> showing what they did in front of people, and teach them to work with patience. (PI-17)

Affective and cognitive outcomes of science fair practices

Examining the views of PSTs regarding the affective outcomes, 93% stated that the interest and love of students for science increased through science fairs, which was parallel with their expectations. For example, in the post-interviews, PSTs shared their views regarding the outcomes of the practice in terms of students as follows:

> We conducted experiments with students. Very creative ideas emerged. Everyone was so eager. They discovered new things in each week we met. A new idea… They strived for days even for preparing posters. I think it contributed much to students. They have never done such practice before. It took their attention, and now they think to conduct other projects in future. (FI-12)
>
> Students learned that science lessons could be more effective, more instructive, and more entertaining. (FI-4)

PSTs also shared that science fair process was both entertaining and beneficial for themselves. For instance:

> The period I spent in secondary schools under the name of community service was very effective and entertaining. I've seen my deficiencies, and found opportunity to reinforce what I've learned in the faculty of education. (FI-18)

PSTs also expressed that the biggest outcome of science fairs was the opportunity to communicate with students (87%). They stated that science fair practices strengthened their communication with students:

> I realized the importance of communicating with students, and how and at what level we should explain the subjects. Briefly, I gained experience even within a short period of time. (FI-5)
>
> It helped me with communicating with students. There are differences between the levels of students, and I gained experience on how to approach them. (FI-26)

Additionally, PSTs stated that students' self-confidence in terms of scientific issues developed through activities (50%). For example, a PST shared that:

> Students were informed about many subjects through conducting experiments and observing other experiments. Conducting experiments provided them self-confidence. (FI-6)

33% of PSTs expressed that students enjoyed learning science. Also, with the same percentage, PSTs indicated that students had the opportunity to work cooperatively. For instance:

> Students' studying with groups enabled them to work better, and to be more active socially. Exchanging ideas when preparing posters and studying together in theoretical part of the experiments were beneficial for them. (FI-18)
>
> Students learned how to study and behave in groups. (FI-33)

60% of PSTs stated that science fairs increased their own self-confidence. They also pointed to the effect of the science fair practice on their future professional career. For instance:

> I now realized that I am having education in science teaching. I got a sight of what kind of job I will do when I graduate, and I liked this profession. (FI-32)
>
> I thought teaching profession was very beautiful and perfect for me. Taking care of students, explaining something to them, and making them feel this sense… I liked that all. I felt like a teacher (FI-12)

Related to the cognitive outcomes, 90% of PSTs expressed that they gained experience, and developed their knowledge and skills regarding science teaching. To give an example:

> I did not know much about the subject and experiment. But then I've studied the subject in detail. Now I can easily guide my students to conduct these experiments in the future. It served as a model for me. (FI-12)

57% of PSTs also mentioned that the science fair practices created opportunities for students to have experience in doing science. For instance:

> I think it provided students with many acquisitions like observing, collecting data, and making deductions. (FI-7)

Additionally, 27% of PSTs indicated that the practices helped students relate science with daily life and other issues (i.e. relating acid-base topic to the detergents used in daily life or to the neutralization of the acid indigestion).

The difficulties related to science fair practices

Table III presents the views of PSTs regarding the difficulties related to science fair practices.

Table III. Prospective science teachers' opinions on the difficulties related to science fair practices

Codes		*Pre-test*				*Post-test*			
		PSTs		*Students*		*PSTs*		*Students*	
		%	*f*	*%*	*f*	*%*	*f*	*%*	*f*
Difficulties	Using chemical matter	3%	1	30%	10	13%	5	3%	1
	Conducting and explaining experiments	40%	12	50%	15	40%	21	43%	16
	Management	20%	7	0%	0	20%	7	0%	0
	Getting attention	10%	3	0%	0	20%	7	3%	2
	Communication	7%	2	0%	0	13%	4	3%	1
	Using materials (manual skill)	0%	0	17%	5	0%	0	13%	4
	Having no challenge	10%	3	7%	2	20%	6	30%	9

40% of PSTs stated that the biggest challenge they expected to encounter during practices were conducting and explaining experiments, while 20% evaluated the biggest challenge as management. In parallel with these predictions, PSTs' evaluations regarding the challenges had the same percentages. For instance:

> Firstly, I had difficulties in communication with students and making explanations to them since they had not heard some concepts before. For

> example, they did not know viscosity etc. at all. Teaching a new concept challenged me. (FI-28)
>
> I had difficulty in answering different and interesting questions from students. I answered them all, but had difficulty. I also had difficulty in our first communication since I was in front of them as a prospective teacher for the first time, and I did not know how to behave (FI-19).

Before science fairs, 50% of PSTs stated that the students might have difficulty in conducting experiments and explaining to their friends, while 30% in using chemicals. After science fair practices, 43% of PSTs stated that the students had difficulty in conducting experiments and explaining them to their friends. For example:

> Students had difficulties while presenting their projects and explaining to their friends. They were shy about telling a wrong thing. They were looking into my eyes while explaining for the fear of making a mistake. They kept their silence when they were stuck, for example one of them broke his/her test tube while presenting his/her experiment, and couldn't continue. But after I encouraged him/her, he/she continued and had no problem after that. (FI-27)

30% of PSTs, on the other hand, stated that students had no difficulty in science fairs practices.

Instructional plans

Table IV shows the views of PSTs regarding instructional plans to be applied in their future teaching career.

Table IV. PSTs' opinions on the instructional plans

Codes		*Pre-test*		*Post-test*	
		%	*f*	*%*	*f*
Instructional plans	Experiment/activity-based teaching	97%	29	100%	42
	Using materials	17%	5	20%	9

Accordingly, before science fair practices, 97% of PSTs stated that they would use experiment and activity based teaching in science lessons, and organize science fairs in their future professional life. For example, two PSTs shared that:

> I would like to organize science fair activities in schools I will serve as a teacher in the future. (PI-14)
> It will be beneficial for students in terms of both gaining responsibility, and observing and understanding different projects through the activities. (PI-17)

This rate was increased to 100% after science fair practices. To provide examples, PSTs stated that:

> As I saw, science fairs attract students. I can make them conduct projects more frequently. I experienced the importance of group study, and saw that giving responsibility to students affects them. (FI-14)
> I plan to conduct such activities when I become a teacher. I plan to develop the skills of students to conduct experiments and communicate through organizing science fairs. (FI-6)

In addition to these, instructional plans regarding material use increased with small rate from 17% to 20%.

Suggestions

Table V presents the suggestions of PSTs regarding science fair practices.

Table IV. PSTs' opinions on the instructional plans

Codes		*PSTs*			
		Pre-test		*Post-test*	
		%	*f*	*%*	*f*
Suggestions	The number of participants	20%	6	23%	8
	Choosing experiment				
	Appropriateness for the level of students	0%	0	50%	16
	Safety	0%	0	23%	7

	Being attractive/visuality	13%	4	47%	20
	The number/type of experiment	27%	8	27%	8
	Duration/frequency of practices	17%	5	40%	13

Accordingly, the views regarding the number of participants in practices showed a slight increase from 20% to 23%. PSTs suggested to increase the number of students assigned in practices, and to expand science fairs to more schools. While before science fairs, no PSTs paid attention to choosing experiments appropriate for the grade level of students, after science fair practices 50% of PSTs stated that the experiments should be appropriate for the grade level of students. Similarly, not sharing any views regarding the safety of experiments before practices, PSTs (23%) indicated the importance of including non-hazardous and safe experiments after the practices. The rate of PSTs emphasizing to choose attractive, visual, and entertaining experiments was low before practices (13%), and increased to 47% after practices. The percentage of PSTs commenting on the period and frequency of practices also increased from 17% to 40%.

Discussion

PSTs' expectations and outcomes of the science fair practices, their difficulties and future instructional plans, and their suggestions are discussed under related sub-titles below.

Affective expectations and outcomes of the science fair practices

Getting Attention/Arousing Curiosity/Endearing Science

Examining the views of science teaching educators, Grote (1995) suggested that the most of the participants' interest and curiosity for science increased after science fairs and projects. Within the context of school, interest is an important variable since it may affect the amount and quality of learning and academic performance (Holstermann, Grube, & Bögeholz, 2010). According to Bruce and Bruce (2000), factors affecting the interests of students in science should be present in their science fair experiences. At this point, Bernard (2011) points that students might be reluctant to prepare projects for science fairs during their first participation in science fairs; however, they can embrace their own studies, and their interest in science fairs can increase over time.

Engel (2011) draws attention to the studies showing that even though children might show curiosity for science in early ages, their curiosity decreases as they age (as cited in Luce & Hsi, 2015). At this point, science fairs can be considered as an effective tool for sustaining or re-arousing the interests and curiosity of students towards science. The findings of the present study are consistent with this view. For instance, according to the field notes taken during the practices, a student -labelled as naughty and lazy by his/her teachers- stated that: *[thanks to this fair] the scientist in me has aroused,* which excited his teachers.

Science fairs can also be beneficial for visitor students. According to Jaworsky (2013), science fair activities can be effective in increasing positive attitudes of visitor students towards science. In the present study, even though direct data regarding the outcomes of the practices were not collected from visitor students, findings obtained from PSTs indicated that visiting students benefited from the practices. For instance, one of the PSTs shared that:

> After observing the experiments conducted by their friends, visitor students stated that they wanted to see such an activity again and participate in the activity this time. (FI-9)

Gaining positive experiences through individual participation in scientific activities (Blenis, 2000) can be determinant in students' future profession preference (Tai, Liu, Maltese, & Fan, 2006). Although little is known about how science fair activities affect students' future profession preference (Dionne et al., 2012; Finnerty, 2013), they are believed to have an influence in the career preference of students (Schmidt, 2014). The findings of the present study also indicated that PSTs were of the opinion that science fairs would have an effect on students' choice of profession. For instance, the following view from one of the PSTs provides an insight on the effect of science fair practices on this issue:

> Such practices may affect students' future. For instance, they may create a model of digestive system, become curious about an area in biology, and draw the figures of organs, then might choose the field of medicine in

> university, or one of them may like to engage in electrical tool and then choose electrical engineering in university. (FI-29)

In addition, there is evidence that science fairs are effective in making visitor students become engaged in science, and prefer a career in science in the future. For instance, a visitor student shared after the science fair that:

> I want to be a science teacher, too. I want to conduct such experiments.

Communication opportunity

PSTs stated that the biggest outcome of science fair practice was the opportunity to communicate with students. Guven (2013) also found that through managing science projects of the 6th grade students within the scope of Community Service course, the prospective teachers became more familiar with students and developed themselves in terms of communicating with students. These results also support the views of Grote (1995) suggesting that science fairs enable prospective teachers to develop their communication skills with students and bring students together with others who are interested in science. Similarly, Sahin and Onder Celikkanli (2014) suggest that having an opportunity to communicate with their friends, teachers, and family members during science exhibits had a positive influence on students.

Enjoyable learning

Barmy, Kind, and Jones (2008) indicate that most students find science lessons boring and non-applicable. At this point, it is important to conduct activities in and out of school which students find entertaining and effective. Examining the factors affecting the participation of students in science fairs, Korkmaz (2012) indicated that entertainment was one of the mostly mentioned factors by students at 4th- 8th grades (9-16 years). In parallel, Abernathy and Vineyard (2001) stated that science fair and Olympic students found science fairs entertaining, and they learned new things through the fair. Similarly, Murray and Reiss (2005) stated that most students found their science experiences entertaining. The findings of the present study also suggest that conducting science fair practices in schools would be convenient in terms of creating opportunities for students to learn science in an entertaining environment. Science fairs also offer the opportunity for prospective teachers to experience an entertaining and beneficial process with the cooperation of universities and secondary schools.

Cognitive expectations and outcomes of the science fair practices

Gaining experience/developing knowledge and skill

Examining their cognitive expectations, PSTs shared that they expected to gain experience and develop knowledge and skills. After the practice, they stated that the science fair practice provided them experience, and developed their knowledge regarding the field and on how to conduct experiments. This is parallel with McCarthy (2015), examining prospective teachers' knowledge and skill development in science through science fairs. Similarly, Guven (2013) reported that prospective teachers taking the responsibility for science project management of secondary school students mentioned that it was a fruitful experience which enabled them to individually study with students before graduation.

In the present study, after the science fair, PSTs stated that the practice created a learning opportunity for both visitor and participating students, and helped them develop their knowledge regarding learning science and conducting experiments. Similarly, according to Guven (2013), project studies conducted by 6th grade students under the guidance of prospective teachers had a significant effect on developing scientific process skills of students. Sahin and Onder Celikkanli (2014) also reported that participating students entertained through conducting experiments, gained new knowledge, and found opportunity to apply what they had learned previously.

Connecting science to daily life

Some of the PSTs thought that science fair practices would contribute students to connect science with daily life. After practices, they also expressed that students were able to connect science with daily life through science fair activities. This finding supports the findings of the study by Dionne et al. (2012) which states that 64% of 36 participants aged between 16-18 years who participated in science fairs thought that participating in science fairs would help them in their daily lives.

The difficulties related to the science fair practices

Regarding the challenges of the science fair practices, PSTs evaluated *conducting and explaining experiments* as the biggest challenge. As suggested by Bischoff and Read (2005), prospective teachers should have full knowledge of the subject they will teach in order to provide education in a way to anticipate the possible questions directed from participants, and guide them with target oriented questions without giving the answer. At this point, prospective teachers should have the skills to listen, observe, and understand what students know (Bischoff & Read, 2005).

In addition, some PSTs regarded management as a challenge to encounter during the process. It was difficult for them to organize students during the practice. Similarly, Guven (2013) reported that organizing students was a challenge for prospective teachers who were guiding secondary school students to conduct projects.

Regarding challenges,Sahin and Onder Celikkanli (2014) reported that some students assigned as participants in science exhibition were aware of the hazardous features of the experiment they conducted as well as materials they used in those experiments. In the present study, only one PST mentioned after the practice that students had difficulty with working with chemicals while some PSTs stated that students had no difficulty at all.

Instructional plans

Before the practice, most of PSTs stated that they would conduct experiments, give activity based education, and organize science fairs in future. After the practices, the number of PSTs planning to use experiments and provide activity based education and organize science fairs was increased. Similarly, Durmaz (2010) conducted a study with 15 science teachers graduated from the same faculty of education and were serving in different provinces of Turkey with professional experience between 1-4 years. She examined the effect of participation in projects they developed when they were prospective teachers and science fairs organized by their faculty of education. All participants stated that developing projects, presenting them, and participating in science fairs positively contributed to their professional development. Half of the participants stated that they organized science fairs in the schools they served after this contribution. The experiences prospective teachers gained during the years of their initial teacher education created a basis for their professional development. From this point, it is believed that including science fair practices in the period of their initial education is appropriate in order to raise prospective teachers who will provide experiment and activity based learning in their future professional life.

The suggestions of PSTs regarding the science fair practice

While choosing experiments according to the level of students was not considered as an issue before the practice, after the practice, half of the PSTs thought that experiments should be appropriate for the level of students. This indicates that PSTs will pay attention to choosing experiments according to the levels of students while organizing science fairs in their future professional life. Similarly, the rate of PSTs thinking that experiments should be attractive, visual, and entertaining was increased after the practice.

The percentage of PSTs commenting on the period and frequency of the practice increased after the science fair. Accordingly, they stated that science fairs should be expanded to 2-3 days rather than being a one-day activity; more students should participate in the fair; and the frequency of the practice should be more than once a year. Similarly, in a study by Guven (2013), prospective teachers complained about time limitation during project guidance. Finnerty (2013) also mentioned limited time as a challenge for both teachers and students during science fair projects.

Conclusion, limitations, and suggestions

To conclude, the aim of the current study was to understand prospective science teachers' expectations, opinions, and suggestions regarding science fair practices. Within the scope of the study, it was hoped that giving prospective teachers opportunities to participate in science fairs would lead them to actively participate in science fairs in future. It is believed that it might be beneficial to provide prospective teachers with science fair opportunities within the scope of Community Service and/or Teaching Methods courses to help them gain rich experiences. Providing prospective teachers opportunities to develop their instructional skills in a community of practice situated in authentic activities is believed to help them learn to teach more effectively and gain broader perspectives. Moreover, creating such opportunities for students in schools through cooperation with universities might be fruitful both for prospective teachers and students in terms of supporting science education. It would also be appropriate to give seminars regarding science fair practices within the scope of teacher training programs. While planning these seminars, it might be recommended to take prospective teachers' opinions about the difficulties they encountered during and their suggestions regarding science fair practices into consideration.

Finally, it should be noted that this study had some limitations. First, the data analysis lacked a strong discussion of efforts to verify the themes observed. Thus, future research is recommended to verify the themes through member checking. It is also suggested to interpret the experience more deeply with respect to the emotions involved. Exploring the possible origins, causes, and nature of prospective teachers' feelings as well as how they relate to appreciation of science is believed to contribute to the findings of the study. Also, in addition to the prospective teachers, it is recommended to collect qualitative data from the participant students in order to understand possible contributions of science fairs on students' learning.

Disclosure statement

No potential conflict of interest was reported by the authors.

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