The Views of Prospective Science Teachers on the Use of Science Centers for Educational Purposes: An Example of Application in Turkey

By

Murat DEMİRBAŞ and Hüseyin Miraç PEKTAŞ
Kırıkkale University, Faculty of Education, Science Education Department,
Kırıkkale University, Faculty of Education, Science Education Department,

Abstract

In this study, the effects of surprising and exciting stimulus fun science experiments, exhibited in the Science and Technology Museum which was founded under the Middle East Technical University, were researched in the aspect of using for the purpose of instruction. For this purpose, the study was carried out by receiving the views of the senior class student's of Kirikkale University Faculty of Education, Science Education. The experiments designed from the 'Hands on Science', aim to convey a lot of physical principles and natural phenomena that we observe in our daily life but not even aware of them, to students in an entertaining environments. Thus, in the study, the views of the teacher candidates on using the activities which are exhibited in the science and technology museum for the instructional purpose are asked. Therefore, semi-structured interview method, often applied, was used in qualitative studies. Interview form consisted of 9 semi-structured questions which contain activities in science center.

Keywords: *Science museum, science teaching, teacher candidates.*

Introduction

Laboratory experiments enable students to develop a positive attitude towards science and scientists, and have a role in choosing a science-related profession (Hofstein and Lunetta, 2004). Today, at every stage of formal education, a number of common educational environments stand out by making sciences, regarded as complicated and inexplicable, popular and easy to understand. According to Hannu (1993), activities carried out beyond formal education resources have an influence on the experiences gained at school. A review of such activities presents science centers as among the leading environments that facilitate learning, arouse interest in and develop positive attitudes towards science.

Science and Technology is a discipline attempting to understand the nature and natural events observed in the universe and based on observations, experiments and quantitative measurements (Temizyurek, 2003). It is thought that students' negative attitudes towards such a discipline can only be overcome through scientific visits that arouse their interest, set them thinking, establish connections with current events and concretize abstract concepts by means of simple experiments. Studies suggest that science centers play a pivotal role in student achievement (Beiers and McRobbie, 1992; Gilbert, 1962; Rix and McSorley, 1999).

Designed by the researchers at the Science and Society Center and exhibited at the Science and Technology Museum, entertaining scientific demonstrations are thought to be surprising, exciting, intriguing and therefore the focal point of students. Designed on the basis of the principle "Touch the Discipline", such experiments communicate many a physical principle and natural event, which we can observe but rarely notice in our daily lives, to students through entertaining mechanisms. The scientific visit organized made an attempt to reveal the fundamental principles in science, current technological developments and the effects of science and technology on our daily lives. The visits to the Science and Technology Museum were organized with the aim of making a visual contribution to instruction and broadening students' horizon on their educational world. It is hoped that the process of instruction will be greatly enhanced when a society not distanced from science is created and students are enabled to get to know some theoretical issues in a visual way through activities in the museum.

Methodology

The Study Model

A qualitative method was employed for the study. The views of the prospective science teachers about the effect of science centers on teaching science were analyzed in a detailed way, as is the case for all qualitative studies, in which the goal is not to make generalizations but to analyze a subject in depth and with a consideration to all possible details (Yildirim and Simsek, 2000). The design was chosen since there was one single unit of analysis (an individual, a school, an institution, etc.)

Data Collection Tool

The study made an analysis of the contributions of the Science and Technology Museum at the Science and Technology Center, the Middle East Technical University (METU), to teaching science within the framework of its experimental sets, the activities carried out at the science center, and content and pedagogic knowledge of the guides at the science center. In this context, the prospective science teachers who visited the Science and Technology Museum were asked to give their views on the visit and answers were sought for the following questions: 1. Had you ever visited a science center before? 2. How do you think the activities at science centers will contribute to students' attitudes towards science? Explain why. 3. Do you consider taking your students to science teachers when you become a teacher? Explain why. 4. What kind of educational attainments will be brought about by the use of science centers for educational purposes? Explain briefly. 5. Do you think that the experimental sets at science centers are sufficient? How do you think they can be improved? 6. Have you sufficiently availed yourself of the activities at science centers? Explain your recommendations, if any. 7. How competent are workers at science centers? Explain your opinions briefly. 8. Are there any differences in your opinions before and after your visit to the science center? Explain. 9. Please explain your opinions, if any, about the shortfalls of science centers in organization.

Data Analysis

The data obtained through semi-structured interviews following the visit were analyzed. Afterwards, they were tabulated and grouped independently by different researchers. Then, the groups were compared and assembled under the same roof. The data were analyzed and their frequency distributions were obtained. The study also included the views of the participants that supported the results of the analysis.

Findings

The Findings as to Whether the Prospective Science Teachers Had Visited Science Centers Before

Following the visit to the Science and Technology Museum at the Science and Society Center, the Middle East Technical University, the prospective science teachers were asked whether they had ever visited a science center during their educational life. The results are presented in Table 1.

Table 1: The data as to Whether the Prospective Science Teachers Had Visited Science Centers Before

The Prospective Science Teachers	Frequency
Those visiting a science center before	6
Those not visiting a science center before	11
Total	**17**

While 11 of the students had not visited a science center before, the remaining six had (Table 1). Out of these six prospective teachers, five of them visited the Feza Gursey Science Center whereas one of them went to the Bilkent University Science Center. It was found that the prospective teachers did not have enough knowledge about science centers. Therefore, prospective teachers should be informed about the contributions of science centers to the process of instruction and education.

The findings as to the Effect of Science Centers to Students' Attitudes to Science

Table 2 presents the views of the prospective teachers on the effect of science teachers to students' attitudes to science.

Table 2. The Views of the Prospective Teachers on the Effect of Science Centers to Students' Attitudes to Science

The effect of Science Centers to Students' Attitudes towards Science	The Prospective Science Teachers		
	Visiting	***Not Visiting***	**Total**
	Frequency	*Frequency*	*Frequency*
1.They help them develop a positive attitude towards science.	6	11	17
2.They help increase their interest in and passion for science subjects.	1	4	5
3.They help them associate science subjects with daily life.	1	3	4
4.They help them concretize abstract science subjects.	1	3	4

5.They help them like science subjects.	1	2	3
6.They help them comprehend science subjects, for visualization is focused.	-	3	3
7. They arouse their interest and encourage them to work in science.	-	2	2
8.They help them comprehend science subjects.	1	-	1
9. They help them learn through trial and experience.	1	-	1
10.They make science entertaining.	1	-	1
11.They encourage them to become a scientist.	-	1	1
12. They enhance their imagination.	-	1	1
13.They ensure permanent learning.	-	1	1
14.They help broaden students' horizon.	-	1	1
15.They increase students' achievement in science courses.	-	1	1

All of the prospective science teachers (17) stated that "science centers help them develop a positive attitude towards science". Other responses are as follows: "they help increase their interest in and passion for science subjects"(5 of them); "they help them associate science subjects with daily life" (4 of them); "they help them concretize abstract science subjects" (4 of them); "they help them like science subjects" (3 of them); "they help them comprehend science subjects, for visualization is focused"(3 of them); "they arouse their interest and encourage them to work in science"(2 of them); "they help them comprehend science subjects" (1 of them); "they help them learn through trial and experience." (1 of them); "they make science entertaining" (1 of them); "they encourage them to become a scientist" (1 of them); "they enhance their imagination" (1 of them); "they ensure permanent learning" (1 of them); "they help broaden students' horizon" (1 of them); and "they increase students' achievement in science courses" (1 of them) (Table 2). Moreover, some of the detailed views of the prospective teachers are as follows:

The Prospective Teacher (Male-1): "*I think that they will make a positive contribution. The reason for this is that I believe they help one comprehend science subjects and associate them with daily life."* ***The*** **Prospective Teacher (Male 2):** "*I maintain that science centers will make a positive contribution to students' attitudes towards science. The reason for this is that this museum and other similar ones increase their interest in science and help them develop a positive attitude to it*." **The Prospective Teacher (Male-3):** "*Science lessons will be boring for students when they are carried out through simple explanation. Such centers are useful for drawing their attention. They are vital for visualization and comprehension."* **The Prospective Teacher (Female-1):** "*Since they are based on visualization, activities at such centers will enable them to develop a positive attitude towards science*." **The Prospective Teacher (Female 2):** *"I absolutely believe that they will have a positive effect. The reason for this is that students will get curious and interested when they see science in a visualized way and in relation to daily life."* **The Prospective Teacher (Female 4):** "*One gets curious about what he/she sees. It is possible that an experiment at science centers will attract students and they will conduct studies on the subject. Therefore, they may turn up to be scientists in the future."*

The Findings as to Whether the Prospective Science Teachers Will Take Their Students to Science Centers When They Become a Teacher

Table 3 presents the reasons for which prospective science teachers will take their students to science centers when they become a teacher.

Five of the prospective teachers stated that they would take their students to science centers because they help develop a positive attitude towards science lessons. The other reasons specified are as follows: "they enable students to learn better and like the lesson" (5 of them); "they ensure permanent learning" (3 of them); "they ensure visualized learning" (3 of them); "they ensure learning through a social activity" (2 of them); "they broaden their horizons" (2 of them); "they enable students to understand the importance of science" (2 of them); "they show how science terminology is used in daily life" (2 of them); "they increase their interest in science" (2 of them); "they enable them to see how advanced science is and what kind of things can be done" (1 of them); "they contribute to their readiness" (1 of them); "they attract their attention" (1 of them); "they change their point of view" (1 of them); "they encourage them to get involved in science" (1 of them); "they make science entertaining" (1 of them); "they increase their moral courage" (1 of them); "they are important for avoiding misconceptions" (1 of them); "they increase the use of knowledge" (1 of them); and "they provide them with the opportunity to witness costly experiments" (1 of them) (Table 3). In addition, some of the detailed views of the prospective teachers are as follows:

Table 3: The Views of the Prospective Science Teachers on the Reasons for Which They Will Take Their Students to Science Centers When They Become a Teacher.

The reasons for which the prospective teachers will take their students to science centers	The Prospective Science Teachers		
	Visiting	***Not Visiting***	**Total**
	Frequency	*Frequency*	*Frequency*
1.I will take them because they help develop a positive attitude towards science lesson	1	4	5
2. I will take them because they enable them to learn better and like the lesson	1	4	5
3.I will take them because they ensure permanent learning.	1	2	3
4. I will take them because they ensure visualized learning.	-	3	3
5.I will take them because they ensure learning through a social activity	1	1	2
6.I will take them because they broaden their horizons.	2		2
7.I will take them because they enable them to understand the importance of science.	-	2	2
8.I will take them because they show how science terminology is used in daily life.	-	2	2
9.I will take them because they increase their interest in science.	-	2	2
10. I will take them because they enable them to see how advanced science is and what kind of things can be done.	1	-	1
11. I will take them because they contribute to their readiness.	1	-	1
12. I will take them because they attract their attention.	1	-	1
13.I will take them because they change their point of view.	1	-	1
14.I will take them because they encourage them to get involved in science.	-	1	1
15.I will take them because they make science entertaining.	-	1	1
16.I will take them because they increase their moral courage.	-	1	1

17.I will take them because they are important for avoiding misconceptions.	-	1	1
18.I will take them because they appeal to more than one sense organ.	-	1	1
19.I will take them because they increase the use of knowledge.	-	1	1
20.I will take them in order to show them costly experiments.	-	1	1

The Prospective Teacher (Male-3): *"I will take my students to science centers because they increase their interest in and passion for science and they are helpful for avoiding misconceptions."* **The Teacher Prospective (Male-4):** *"I will take my students to science centers because they ensure visualized learning and help them increase their moral courage through visits."* **The Prospective Teacher (Male-6):** "*At such centers, students gain a better insight into the importance of science to our lives. In addition, activities carried out at such places increase their interest in science".* **The Prospective Teacher (Female-4):** "*I will take my students to science centers because I believe that learning and seeing something at first hand will make them more interested in my lessons."* **The Prospective Teacher (Female-5):** *"I will take my students to science centers because they manage to make students like science, they show that science can be used in daily life, they appeal to more than one sense organ and they ensure permanent learning".* **The Prospective Teacher (Female-9):** *"I want my students to like science lessons better. I will take them because different instructional activities will ensure a better learning".*

The Findings as to the Potential Attainments Brought about by the use of Science Centers for Educational Purposes

Table 4 presents the views of the prospective science teachers as to the potential attainments brought about by the use of science centers for educational purposes.

Table 4. The Views of the Prospective Science Teachers as to the Potential Attainments Brought about by the use of Science Centers for Educational Purposes.

The Potential Attainments Brought about by the use of Science Centers for Educational Purposes	The Prospective Science Teachers		
	Visiting	***Not Visiting***	**Total**
	Frequency	*Frequency*	*Frequency*
1.They enable students to develop the habit of making observations.	3	3	6
2.They enable students to develop the habit of associating science with daily life.	2	2	4
3. They enable students to develop the habit of discovering things.	1	3	4
4. They enable students to develop the habit of experimenting.	1	2	3
5. They enable students to develop the habit of creative thinking.	1	1	2
6. They enable students to develop the habit of questioning.	2	-	2
7. They enable students to develop the habit of comprehending.	-	1	1
8. They enable students to develop the habit of being curious.	-	1	1
9. They enable students to develop the habit of reasoning.	-	1	1

10. They enable students to develop the habit of being critical.	-	1	1

The responses of the prospective teachers are as follows: "they enable students to develop the habit of making observations" (6 of them); "they enable students to develop the habit of associating science with daily life" (4 of them); "they enable students to develop the habit of discovering" (4 of them); "they enable students to develop the habit of experimenting" (3 of them); "they enable students to develop the habit of creative thinking" (2 of them); "they enable students to develop the habit of questioning" (2 of them); "they enable students to develop the habit of comprehending" (1 of them); "they enable students to develop the habit of being curious" (1 of them); "they enable students to develop the habit of reasoning" (1 of them); "they enable students to develop the habit of being critical." (1 of them) (Table 4). A review of literature suggests that students' problem-solving skills will get enhanced in those environments in which scientific experiments and projects are carried out (Paris, Yambor and Packard, 1998). Furthermore, some of the detailed views of the prospective teachers are as follows:

The Prospective Teacher (Male-2): "*When students are directly engaged in such activities, they will be enabled to acquire such skills as discovering and observing."* **The Prospective Teacher (Male-5):** *"They enable them to develop the habits of observing, reasoning, creative thinking and being critical".* **The Prospective Teacher (Female-6):** *"They enable them to develop the habits of observing, experimenting, discovering and associating what they have discovered with daily life".* **The Prospective Teacher (Female-7):** "*Students will learn how to use what they have learned in their daily lives and develop the habit of reasoning*".

The findings as to the Sufficiency of the Experimental Sets at Science Centers

Table 5 presents the views of the prospective science teachers as to the sufficiency of the experimental sets at science centers.

Table 5. The Views of the Prospective Science Teachers as to the Sufficiency of the Experimental Sets at Science Centers.

The Sufficiency of the Experimental Sets at Science Centers	The Prospective Science Centers		
	Visiting	***Not visiting***	**Total**
	Frequency	*Frequency*	*Frequency*
1.They should be enriched with different experimental sets.	2	4	6
2.They should include more experiments on current issues.	1	5	6
3.They are generally based on physics; they should be developed also in biology and chemistry.	1	2	3
4.All institutions should be in cooperation with each other.	1	-	1

Six of the prospective teachers noted that they should be enriched with different experimental sets. The other responses are as follows: "they should include more experiments on current issues" (6 of them); "they are generally based on physics; they should be developed also in biology and chemistry" (3 of them); and "all institutions should be in cooperation with each other" (1 of them) (Table 5).). Moreover, some of the detailed views of the prospective teachers are as follows:

The Prospective Teacher (Male-1): "*No, they are not sufficient. Nothing is sufficient for science. Different experimental sets can be designed on different subjects."* **The Prospective Teacher (Male-4):** "*They are sufficient for Physics subjects, yet insufficient for Chemistry and Biology subjects".* **The Prospective Teacher (Male-7):** "*Most of the sets are designed for Physics. A few sets in Chemistry and Biology could be added to the existing ones".* **The Prospective Teacher (Male-5):** "*Insufficient. What we have seen is about only a few studies. There are many intriguing subjects in science. They should be added to the existing ones".* **The Prospective Teacher (Female-4):** *"I do not think they are sufficient, for science is open to improvement. Therefore, new experiments should be added with each new development".* **The Prospective Teacher (Female-5)**: *"Yes, they are sufficient. However, it is a must that new ones should be added in accordance with each developing scientific issue and technology."* **The Prospective Teacher (Female-7):** "*Sufficient. As far as I can see, science centers are constantly renewed. They provide students with invaluable information."* **The Prospective Teacher (Female-9):** "*Yes, they are sufficient. There were similar experimental sets at the Feza Gursey Science Center. They should be enriched with different experimental sets."* **The Prospective Teacher (Female-10)**: "*Out of the science centers I visited, some of them were sufficient whereas others were not. The efforts to improve such science centers should be undertaken in cooperation with all institutions."*

The Findings as to the Presentation of the Studies at Science Centers

Table 6 presents the views of the prospective science and technology teachers as to the presentation of the studies at science centers and their recommendations for improving it.

Table 6. The Views of the Prospective Science and Technology Teachers as to the Presentation of the Studies at Science Centers and Their Recommendations for Improvement.

The views as to the Presentation of the Studies at Science Centers and Recommendations for Improvement.	The Prospective Science Teachers		
	Visiting	*Not Visiting*	Total
	Frequency	*Frequency*	*Frequency*
1. We have sufficiently availed ourselves of the information presentation.	6	11	17
2. Students could be provided with more opportunity for practice.	-	1	1

All of the prospective teachers (17) stated that they had sufficiently availed themselves of the information presentation. As for the recommendations for improving it, only one of the prospective teachers proposed that students could be provided with more opportunity for practice.

The findings as to the Knowledge Competency of the Workers at Science Centers

Table 7 presents the views of the prospective science teachers as to the knowledge competency of the workers at science centers.

Table 7. The Views of the Prospective Science Teachers as to the Knowledge Competency of the Workers at Science Centers

The views as to the Knowledge Competency	The Prospective Science Teachers		
	Visiting	***Not Visiting***	**Total**
	Frequency	*Frequency*	*Frequency*
1.His knowledge level was quite satisfactory.	6	11	17
2.He could explain things in a fluent manner.	1	1	2
3.He could convey his-her knowledge in a proper way.	1	1	2
4.He had no disconnection while speaking.	1	-	1
5.He explained the subjects through examples from daily life.	-	1	1

All of the prospective teachers (17) noted that his knowledge level was quite satisfactory. The other responses are as follows: "he could explain things in a fluent manner" (2 of them); "he could convey his knowledge in a proper way" (2 of them); "he had no disconnection while speaking" (1 of them); and "He explained the subjects through examples from daily life" (1 of them) (Table 7). In their study, Tenenbaum et al. (2004) observed that students will gain great benefit from decent guidance of the workers at museums. Therefore, it is important that workers at museums should be more qualified and caring.

The findings as to the Differences in the Opinions of the Prospective Science Teachers Before and After Their Visits to Science Centers.

Table 8 presents the views of the prospective science teachers as to the differences in their opinions before and after their visits to science centers.

Table 8. The Views of the Prospective Science Teachers as to the Differences in Their Opinions Before and After Their Visits to Science Centers.

The Opinions of the Prospective Teachers Before and After Their Visits to Science Centers	The Prospective Science Teachers		
	Visiting	***Not Visiting***	**Total**
	Frequency	*Frequency*	*Frequency*
1.My interest in scientific studies got increased.	6	11	17
2.I have started to believe that such places are necessary.	1	2	3
3.I had expected to see more advanced technologies. However, I saw more experimental sets on basic sciences.	1	1	2
4.I had not expected to see such well-designed devices.	-	2	2
5.I had expected the visit to be rather boring, yet it was very amusing and entertaining.	-	2	2
6.I will take my students to such places when I become a teacher.	-	1	1
7. Now I have more positive attitude towards science.	-	1	1
8. My world view has changed.	1		1
9. I have understood that not everything turns up to be as one expects.	-	1	1

All of the prospective science teachers (17) noted that their interest in scientific studies got increased. Furthermore, three of them stated that they had started to believe that such places are necessary whereas two of them admitted that they had expected to see more advanced technologies but rather saw experimental sets mostly on basic sciences. The other responses are as follows: "I had not expected to see such well-designed devices" (2 of them); "I had expected the visit to be rather boring, yet it was very amusing and entertaining" (2 of them); "I will take my students to such places when I become a teacher" (1 of them); "I have more positive attitude towards science" (1 of them); "my world view has changed" (1 of them); and "I have understood that not everything turns up to be as one expects" (1) (Table 8). Furthermore, some of the detailed views of the prospective teachers are as follows:

The Prospective Teacher (Male-1): "*Now I am more interested in scientific studies. Furthermore, I would like to be at such centers."* **The Prospective Teacher (Male-6):** "*I had expected to see more technology-based studies. Nevertheless, I saw simple but useful studies in science. I saw visualized studies which promote students to think."* **The Prospective Teacher (Male-7):** "*I had not expected to get so amused. I participated in quite amusing experiments."* **The Prospective Teacher (Female-1):** "*It was more beautiful, amusing and interesting than I had expected. I had not thought that I would learn and get entertained at a science center."* **The Prospective Teacher (Female-3):** *During the visit, I saw that such places are quite useful and I have absolute plans to take my students to such places when I become a teacher."* **The Prospective Teacher (Female-4):** "*Prior to the visit, I did not know what kind of scientific studies I would see. Following the visit, seeing a number of subjects in a concretized manner made me more sensitive to what I knew and did not know*." **The Prospective Teacher (Female-5):** "*I had expected the visit to be boring, for I had had no idea. However, I changed my mind and liked it a lot when I saw and actively participated in the experiments."*

The Findings as to the Shortfalls of Science Centers in Organization

Table 9 presents the views of the prospective science teachers as to the shortfalls of science centers in organization.

Table 9. The Views of the Prospective Science Teachers as to the Shortfalls of Science Centers in Organization.

The Shortfalls of Science Teachers in Organization	The Prospective Science Teachers		
	Visiting	***Not Visiting***	**Total**
	Frequency	*Frequency*	*Frequency*
1.Such centers should be a commonplace.	1	2	3
2.Different experiments should have been included.	1	-	1
3.General focus was on physics; other sciences were neglected.	1	-	1
4. Any person should have the opportunity to benefit from such centers easily.	1	-	1
5. A lack of publicity is prevailing. Not everybody knows these centers.	-	1	1
6. They could have been designed more properly; they were rather messy.	-	1	1
7.More focus could have been provided for visualization.	-	1	1

Three of the prospective teachers stated that such centers should be a commonplace. The other responses are as follows: “different experiments should have been included” (1 of them); “general focus was on physics; other sciences were neglected” (1 of them); “any person should have the opportunity to benefit from such centers easily” (1 of them); “a lack of publicity is prevailing; not everybody knows these centers” (1 of them); “they could have been designed more properly; they were rather messy” (1 of them); and “more focus could have been provided for visualization” (1 of them) (Table 9).

Discussion and Conclusion

As for whether the prospective science teachers had visited a science center before, 11 out of the 17 prospective science teachers had never visited a science center or seen such practices before. This finding is in consistent with that of Bozdogan and Demirbas (2006). Thus, students should be made aware of such centers starting from primary school age. Prospective teachers should be made aware of the contributions of such centers to the process of instruction and education. As for the effect of science centers on the students’ attitude towards science, all of the prospective teachers stated that science centers help them develop a positive attitude towards science. That means that the prospective teachers are aware of the contributions of science centers to teaching science. In parallel with the findings of the present study, according to Bozdogan and Yalcin (2006), science centers are quite influential in arousing and maintaining students’ interest in science.

As for the findings as to whether the prospective science teachers will take their students to science centers when they become a teacher, they stated that they would do so because “they help develop a positive attitude towards science lesson”; “they enable them to

learn better and to like the lesson"; "they ensure permanent learning"; "they ensure visualized learning"; "they ensure learning through a social activity"; "they broaden their horizons"; and "they make science entertaining". In parallel with these findings, Hannu (1993) maintained that activities carried out outside of formal education resources have an influence on the development of the experiences gained at school. In the light of all these statements, the prospective teachers can be said to be aware of how important learning through practice and experience is important. These findings are supported by that of Bozdogan (2008). As for the findings as to the contributions of the use of science centers for educational purposes, the prospective teachers noted that "They enable students to develop the habit of making observations", "They enable students to develop the habit of associating science with daily life", "They enable students to develop the habit of discovering things", "They enable students to develop the habit of experimenting" and "They enable students to develop the habit of creative thinking". These findings suggest that the prospective teachers are able to realize the potential attainments brought about by the visits to science centers.

As for the findings as to the sufficiency of the experimental sets in science centers, the prospective teachers noted that "they should be enriched with different experimental sets"; "they should include more experiments on current issues"; "they are generally based on physics; they should be developed also in biology and chemistry"; and "all institutions should be in cooperation with each other. In the light of these findings, one can argue that science centers should have more numerous experimental sets and they should have a richer content in sciences. Moreover, all educational institutions should pay more attention to scientific visits in cooperation with each other. As for the findings as to the presentation of the studies conducted at science centers, all the prospective teachers noted that "they had sufficiently availed themselves of the information presentation." Based on the findings, it is thought that workers at science centers are competent in presentation. This finding is in parallel with that of Bozdogan (2008). It was observed that the guides have enough pedagogical content knowledge and devote sufficient attention to the visitors.

As for the recommendations for improving the studies at science centers, the prospective teachers noted that "students should be provided with more opportunity for practice". Since visits to science centers generally last for a short time, experiments are usually based on demonstration and therefore visitors are not provided with much opportunity for practice. Attempts should be made to improve and expand science centers across the country and the number of voluntary workers should get increased. As for the findings as to the knowledge competency of the workers at science centers, all the prospective teachers noted that "his knowledge level was satisfactory". Since the workers at science centers are, in a way, hosts, they should be really successful in influencing visitors positively. According to Chi-Chin (1995), the guides at science centers have a key role in having an effect on students. Therefore, more attention should be paid to the process of recruitment.

As for the findings as to the opinions of the prospective science teachers before and after their visits to science centers, all the prospective teachers stated that their interest in scientific studies got increased. Among the other responses are "I started to believe that such places are essential", "I had expected to see more advanced technologies. However, I saw

more experimental sets on basic sciences", "I had not expected to see such well-designed devices", "I had expected the visit to be rather boring, yet it was very amusing and entertaining" and "I will take my students to such places when I become a teacher". The findings suggest that science teachers leave a favorable impression on the prospective teachers. It is thought that the prospective teachers will be more knowledgeable and train their students in a more sensitive manner.

As for the findings as to the shortfalls of science centers in organization, the prospective teachers stated that "such centers should be a commonplace"; "different experiments should have been included"; "general focus was on physics; other sciences were neglected"; "any person should have the opportunity to benefit from such centers easily"; "a lack of publicity is prevailing; not everybody knows these centers"; "they could have been designed more properly; they were rather messy"; and "more focus could have been provided for visualization". In addition, as stated by the prospective teachers, attempts should be made to increase the number of science centers across the country and experimental sets should focus on each discipline of sciences. Science centers should be publicized more effectively and all educational institutions should be made aware of such centers.

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Appendix: Examples of application