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The effect of science centres on perceptions of secondary school students towards the nature of science

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In the study reported on here, the effects of science centres on the perceptions of secondary school students towards the nature of science were examined. The study group consisted of 16 students aged 13 and 14 of which 7 were female and 9 male. In this study, a total of 4 trips were arranged to the science centre twice a month for 2 months. Students attended different workshops, planetariums and exhibitions on each trip to the science centre they attended. The activities that students attended during these trips were independent of the school curriculum. The data were obtained in the spring of 2019. This study was experimental research. Mixed method was used as the research model and the concurrent triangulation pattern was used as the design. The Scientific Knowledge Scale, the Questionnaire for Scientific Knowledge and semi-structured interviews were used as data collection tools, which were administered to students before and after the activities. In data analysis, qualitative data were analysed using content analysis. Quantitative data were analysed using the SPSS program. As a result of the research, it was determined that science centres caused an increase in students' scores and levels of scientific knowledge and an improvement in their views on the nature of science.

Keywords: learning environments; nature of science; out-of-school learning; perception; science; science centres; secondary school; student

Introduction

Science can be conceptually defined as the effort to find and explain facts about the world using observation and reasoning. Science is actually more than a concept. It is science that guides many developments in the world. The world has developed in parallel with science (Whitehead, 2011).

Bell (2008) states that science is a multidimensional concept. The nature of science is one of the dimensions of science. It plays a big role in understanding the importance of science and society. Individuals who learn the nature of science understand science and its place in current life and make connections and adopt ideas on scientific problems to become more successful. A relationship exists between science teaching and individuals' views on the nature of science (Mugaloglu & Bayram, 2010). The teaching of the nature of science should be among the objectives of science education (Herman, Clough & Olson, 2013; Tao, 2003).

Researchers suggest that the nature of science should be included in the science curriculum and that the role of the teacher in the teaching of the nature of science cannot be ignored (Abd-El-Khalick & Lederman, 2000; Coleman, Stears & Dempster, 2015; Hogan, 2000). The teaching of the nature of science should prepare individuals for societies dominated by science in the future (Tairab, 2001).

The research was conducted at the Uskudar Science Centre, Istanbul. In practice, trips to the science centre were arranged twice a month for 2 months. The activities in which the students participated at the science centres were independent of the school curriculum. The reason for this was that students from different schools participated and curriculum parallelism between schools could not be maintained. Data were collected from the students before and after each science centre visit.

Literature Review

In the modern world the importance of science and individual's understanding thereof in order to develop cannot be underestimated (Wicaksono, Minarti & Roshayanti, 2018). Individuals with a good understanding of science contribute to development in every field, especially in technology and the economy. This ensures that societies develop in all areas and increase their levels of welfare. Science is thus a crucial element for the advancement of societies (Wong, Hodson, Kwan & Yung, 2008).

As science is complex and multidimensional, multiple definitions of the nature of science exist (Kang, Scharmann & Noh, 2005). The nature of science is generally defined as a discipline that is shaped by imagination and creativity, is affected by the social and cultural environment in which it exists, is open to change and contains subjective scientific knowledge. In another definition, the nature of science is defined as the field of study that examines science and the factors affecting science from historical, social, psychological and philosophical perspectives (McComas & Olson, 2000). Based on these definitions, the definition of the nature of science adopted in this study is that the nature of science includes the changeable, experimental, subjective, creative, social and cultural structure of scientific knowledge (Schwartz & Lederman, 2002). According to Osborne, Collins, Ratcliffe, Millar and Duschl (2003), it is the field of study that focuses on the historical process and precision of scientific knowledge for the nature of science, and deals with the analysis and interpretation of data. The importance of teaching the nature of science in developing perceptions and thinking towards the nature of science has been identified in the literature (Dudu, 2014; Nuangchalerm, 2009; Sridevi, 2013; Yoon, Suh & Park, 2014).

Irwin (2000) examined the use of historical perspective in teaching the nature of science. For this purpose, the atom as subject and the periodic table were studied using historical materials. As a result of the research, it was found that the secondary school students understood the nature of science better.

In a study conducted by Bell, Blair, Crawford and Lederman (2003), the effect of 8-week laboratory assistantship training on high school students' perceptions of the nature of science was investigated. In order to determine the effectiveness, the students' views of nature of science questionnaire, Form B (VNOS-B) test was applied as a pre-test and a post-test. As a result of the research, it was determined that the students' knowledge about the nature of science had improved.

In a study conducted by Akerson and Donnelly (2010:102), the effect of the "Saturday science" program (activities related to the nature of science) on students' perceptions of the nature of science were investigated. The study was implemented for 2.5 hours per week for 6 weeks, and the pre-test and post-test Views of Nature of Science Form D (VNOS-D) were administered to the students. As a result of the research, it was found that primary school students' understanding of the nature of science had improved.

Teaching the nature of science in science education has increased the importance of science education. Science education in schools is formal, planned, ordered and clearly defined; however, education at school is limited to the school environment only. For a long time, the main role in science education has been attributed to schools, but more recently, the wide range of out-of-school educational institutions has increased their share in science education (Falk & Dierking, 2000). Classroom learning should be supported by out-of-school learning (James & Williams, 2017; Karppinen, 2012).

Out-of-school learning is concerned with how and where teaching is conducted and broadens the boundaries of the school (Sjöblom & Svens, 2019). In out-of-school learning, student experiences are created by performing many activities outside the classroom (Behrendt & Franklin, 2014; Gerber, Marek & Cavallo, 2001).

There has been a significant increase in the number of studies on out-of-school learning, especially in international literature (Hull & Schultz, 2001; Humberstone, 2011; Pugh & Bergin, 2005; Thomas, 2015). Classroom and out-of-school learning are two parts of a whole that complement each other.

Out-of-school learning environments are referred to as non-formal and informal learning places. Informal learning is not compulsory and is not structured. In informal learning, there is no specific environment. Examples of these can be parks, streets, homes, and friends' environments. Non-formal learning is the intersection of formal and informal learning. Non-formal learning offers structured, experience-oriented and motivated learning. Non-formal learning takes place in an out-of-school learning environment, which is a special learning environment. This environment can provide students with concrete experiences that enable them to interact physically with objects not found in formal science classes (Allen, 2004). Examples are planetariums, nature and history museums, science centres, botanical gardens, aquariums, and zoos (Eshach, 2007).

Science centres are the richest out-of-school learning environments and offer science and technology to people of all ages in society (Walton, 2000). In science centres, people learn about scientific subjects. They also acquire scientific process skills and satisfy their curiosity for science (Young, 2012).

Science centres are special environments where scientific learning experiences are shared and are separate from school environments (Vinson, 2006). These centres make it easier for people to access scientific knowledge. At science centres, students have the opportunity to conduct experiments. For example, a student can see and touch objects on a subject learned in a science class in the science exhibition or conduct experiments on that topic in the science workshop (Falk & Needham, 2011). Science centres offer their visitors a fun and exciting experience (Falk & Gillespie, 2009). These centres increase students' curiosity, interest and motivation towards science (Sasson, 2014).

The number of studies on science centres reported on in the literature are increasing (Belin, 2018; Martinez, 2016; Radzilowicz, 2008; Sommerkamp, 2005) and many studies on the importance of the role of science centres in society (Morris, 2014; Ogbomo, 2010) are available. According to Zimmerman, Reeve and Bell (2010), science centres meet society's need for science education. Toon (2003) argues that science centres act as a bridge between experts in society and citizens. Science centres also ensure that society fuses with science (Pilo, Mantero & Marasco, 2011).

However, few studies have been found on what effects the activities carried out at science centres have on the participants' perceptions of the nature of science. JS Lederman and Holliday (2017) examined the views of science centre personnel on the nature of science. As a result of the study, it was determined that the science centre staff had misconceptions about the changeability of scientific knowledge and the discrimination of theory and law. In some other studies, the place of science centres and out-of-school learning environments in science education was mentioned (Falk & Needham, 2011; Stocklmayer, Rennie & Gilbert, 2010). With this study we expect to contribute to the literature as it shows that science centres can be used in the education on the nature of science and to draw attention to the important role of these centres in science education.

For this reason, the problem statement of this research was: "How do educational programmes in science centres affect students' perceptions and views about the nature of science?"

Theoretical Framework

Nature of science

The nature of science is a concept without boundaries because science is open to development. Therefore, it is not possible to provide a precise definition of the nature of science and many definitions and explanation exist in science education literature (Kelly & Erduran, 2019).

The nature of science is a general concept that includes the historical development of science, the way scientists work, the principles and assumptions of scientific knowledge (Lederman, NG 2007). In the nature of science, the types of scientific knowledge, ways of accessing scientific information, the way scientists work, and the science-technology-society triangle are mentioned (Ramnarain & Padayachee, 2015). As science continues to evolve, the scope of the nature of science will change (Yalvac & Crawford, 2002). According to McComas (2000), there are five dimensions of the nature of science: observation and experimentation, changeability, imagination and creativity, subjectivity, and social and cultural aspects.

Understanding the place and importance of science in everyday life, and understanding scientific norms and materials can be achieved largely by learning the nature of science (Wicaksono et al., 2018). Accordingly, understanding the complex nature of science is crucial for the development of science. Based on this idea, in our study, science centres, which are special learning environments, were used to understand the nature of science and the effectiveness of science centres in the education of the nature of science.

Methodology

Research Model

Mixed method research was used in this study. Both qualitative and quantitative methods are used in data collection and analysis in mixed method studies. Mixed method studies are studies that act as a bridge between qualitative and quantitative studies (Onwuegbuzie & Leech, 2004). The purpose of using mixed methods in this study was to increase data diversity and to strengthen qualitative and quantitative data (Creswell, 2003).

Convergent parallel patterns, one of the mixed method designs, was used. Thus, the data were independently obtained and analysed through both qualitative and quantitative methods and interpreted together. In convergent parallel design, the collection and analysis of qualitative and quantitative data are performed at same time and independently. The analysed data are equally valuable and are combined and interpreted (Tashakkori & Creswell, 2007).

The Implementation/Science Centre Visits

The research was carried out at the Uskudar Science Centre, Istanbul. Trips to the science centre were arranged twice a month for 2 months. The students attended different education programmes at the science centre during each visit (Table 1).

Table 1 Weekly science centre education programmes, educational content and time

Weeks	Activity name	Educational content	Time
1st week	Mysterious universe	Astronomy, aviation and space workshop	70 minutes (min.)
	Exploration of space and birth of technology	Planetarium	30 min.
	Electricity and magnetism exhibition unit	Exhibition space	30 min.
2nd week	Insect101	Natural sciences workshop	70 min.
	Our cells	Planetarium	30 min.
	Sight exhibition unit	Exhibition space	30 min.
3rd week	Palaeontology	Natural sciences workshop	70 min.
	Astronaut	Planetarium	30 min.
	Perception exhibition unit	Exhibition space	30 min.
4th week	Sphere of life	Astronomy, aviation and space workshop	70 min.
	Universe and life	Planetarium	30 min.
	Resonance and waves exhibition unit	Exhibition space	30 min.

Sample Group

The appropriate sampling method was used in this study. The aim of the appropriate sampling method is to choose the most practical sample that saves time and access for research (Dörnyei, 2007). While applying the appropriate sampling method in this study, we tried to choose the easiest sample for the study, taking into account students' willingness and their ability to easily participate in all trips.

A sample of 16 students from a population of 134 students was chosen as the sample to obtain deeper and more detailed data from the sample. In addition, it was necessary to select a small sample size for the effectiveness and controllability of the intensive training programme, which was implemented in the weekly excursions with the sample.

The 16 students (seven male and nine female) in the sample were secondary school students in the eighth grade.

Data Collection Tools

The Scientific Knowledge Scale, the Questionnaire for Scientific Knowledge and semi-structured interviews were used as data collection tools.

The Scientific Knowledge Scale is a quantitative data collection tool used to collect information about students' views on scientific knowledge. The internal consistency coefficient of the scale was found to be Alpha 0.65.

The Questionnaire for Scientific Knowledge developed by Smith, Maclin, Houghton and Hennessey (2000) was also used. This questionnaire consists of open-ended questions which the students were asked to answer in writing. Students were given 30 minutes in the classroom environment to complete the questionnaire after which the completed questionnaires were collected from the students.

The Views of Nature of Science Questionnaire (VNOS) was used for the interview form. This questionnaire was developed by NG Lederman, Abd-El-Khalick, Bell and Schwartz (2002). In our study, the primary education version of the questionnaire, "Views of Nature of Science Questionnaire Elementary Level (VNOS-E)" was used. The questionnaire contains seven open-ended questions. In order to increase both validity and reliability, it was aimed to get deeper answers to the questions in the questionnaire. For this reason, the questionnaire was used as an interview form in the semi-structured interviews with students. The students were asked questions about the variable structure of scientific knowledge, the ways of reaching knowledge, the precision of scientific knowledge, the relationship between science and imagination, and the characteristics of science. The application of the questionnaire and the interviews lasted 20 minutes.

Data Analysis

Descriptive analysis was used in the analysis of the Scientific Knowledge Scale. The responses, "Agree [Yes], No Idea, Disagree [No]" were numbered as "3, 2 and 1", respectively. The highest score that can be obtained from the scale is 48 and the lowest score is 0. The students' answers were scored by entering them into the SPSS program. The high score obtained from the scale can be shown as evidence that the students had knowledge in defining and specifying the characteristics of scientific knowledge.

Content analysis was performed in the analysis of the data obtained from the Questionnaire for Scientific Knowledge. There are five sections in the Questionnaire for Scientific Knowledge (see Table 2) as well as explanations of the levels and levels for each section (Smith et al., 2000). Levels are generally indicated as 0, 1, 2, 3 and 4. Zero indicates the lowest level, while 4 indicates the highest level. In the analysis of the Scientific Knowledge Questionnaire, students' answers were evaluated based on the criteria in the categories.

Table 2 Sections and topics of sections of the questionnaire for scientific knowledge

Sections of questionnaire	Topics of sections
1st section	Purpose of science
2nd section	Scientific questioning
3rd section	Scientific studies
4th section	Scientific knowledge
5th section	Scientific justification

Content analysis was also conducted on the semi-structured interview form. The answers that the students provided during the interviews were recorded and then transcribed, after which the data were converted into codes. The frequency and percentage values of the codes were determined.

Results

The results from the Scientific Knowledge Scale, the Questionnaire for Scientific Knowledge and the semi-structured interviews are presented below.

Results from the Scientific Knowledge Scale

The results obtained from the students on the Scientific Knowledge Scale are presented in Table 3.

Table 3 Arithmetic averages and standard deviations of students' Scientific Knowledge Scale (SKS) pre-test scores

Scale used	Sample group	*N*	X	Maximum point	*SD*
Scientific Knowledge Scale	One group	16	33.68	48	2.91

Before the implementation, the students achieved an average of 33.68 points out of 48 points. This value indicates that the students' scores were far from the maximum score. After the implementation, the students got an average of 40.87 points out of 48 points (see Table 4). This value indicates that the students had achieved a score closer to the maximum score.

Table 4 Arithmetic averages and standard deviations of students' SKS post-test scores

Scale used	Sample group	*N*	X	Maximum point	*SD*
Scientific Knowledge Scale	One group	16	40.87	48	3.50

The Wilcoxon signed rank test is a frequently-used non-parametric test for paired data consisting of pre- and post-measurements. In this study, the Wilcoxon signed rank test was used in the SPSS program because of the sample size and the comparison of the pre- and post-tests (Rosner, Glynn & Lee, 2006).

Table 5 Results of Wilcoxon signed ranks test

Scale used	Tests	X	*SD*	**p*
Scientific Knowledge Scale	Pre-test	33.68	2.91	.001
	Post-test	40.87	3.50	

Note. *$p < 0.05$ significant.

As seen in Table 5, there was a significant difference between the students' pre-test and post-test scores. The significant difference was in favour of students' post-test scores.

Results from the Questionnaire for Scientific Knowledge

The section, "Purpose of Science" contains three questions (Questions 1, 2 and 3). Before the implementation, 15 students answered level 1, one student answered level 2, and there was no response from level 3. After the implementation, four students answered level 1, seven students answered level 2, and five students answered level 3. Accordingly, before the implementation, almost all of the students stated only concrete activities as the aim of science, while after the implementation, the students mentioned the relation of science with thought and working methods of science in addition to concrete activities.

Three questions (Questions 4, 5 and 6) appear in the section, "Scientific Questioning." Before the implementation, two students answered at level 0, and 14 students at level 1. No students answered at levels 2, 3 and 4. After the implementation, six students answered at level 1, five students at level 2, two students at level 3, and three students answered at level 4. No student responded at level 0. According to these responses, before the implementation the students were of the opinion that scientists did not ask questions or asked concrete questions at the level of basic curiosity. After the implementation they were of the opinion that scientists asked deeper scientific, abstract and complex questions in addition to concrete questions.

The section, "Scientific Studies" contains three questions (Question 7, 8 and 9). Before the implementation, nine students answered at level 1, and seven students answered at level 2. No students answered at levels 3 and 4. After the implementation, seven students answered at level 1, five students at level 2, one student at level 3, and three students answered at level 4. From these responses we could deduce that, before the implementation students thought that the mistakes made in scientific studies only occurred due to the lack of information and technology, but after the implementation it was found that they were of the opinion that the wrong thoughts could also lead to errors and that ideas were tested and developed through studies.

In Question 9 of the section, "Scientific Studies" one student answered at level 1, and 15 students gave level 2 answers before the implementation with no answers at level 3. After the implementation, eight students answered at level 2 and eight students answered at level 3 – no students at level 0. Based on these responses, before the implementation almost all of the students thought that precise information would be obtained when careful effort was put into very scientific studies, while after the implementation, half of the students thought that scientific studies were used to justify their ideas and that definite information could not be obtained.

Before the implementation, 12 students answered at level 1 and four answered at level 2 to the four questions (Questions 10, 11, 12 and 13) in the section "Scientific Knowledge." No students answered at level 3. After the implementation, seven students answered at level 1, two students answered at level 2, and seven students answered at level 3. Most of the students were thus of the opinion that scientists reached scientific knowledge by discovering only through concrete activities but after the implementation, students also thought that scientists reached scientific knowledge while developing their thoughts.

The section, "Scientific Justification", contains four questions, two scenarios and two open-ended questions. Before the implementation, 10 students answered at level 1, six at level 2 answers, and none at level 3. After the implementation, three students answered at level 1, nine students at level 2 and four students answered at level 3. Before the implementation students evaluated the scientific justification as creating result-oriented and concrete products; after the implementation they considered scientific justification as the development of scientists' ideas.

Results from the Semi-structured Interviews

To the question, "What is science?", the answers given by the students before and after the implementation were as follows:

Question: What is science?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
Searching	3	Searching	7
Curiosity and discovery	3		7
Experiment and observation	2	Creativity	4
Method of proving knowledge	2	Method of proving knowledge	3
Studies on life	1	Observation	3
Professors' formulas	1	Trial and error	2
Formation of the universe	1	Answering questions	2
Failure and studying	1	Experimenting	2
Method of questioning the universe	1	Sense of curiosity	1
Revealing the laws of the world	1	Variability	1
The result of perseverance and working	1		
The occupation of intelligent people	1		
Logical thinking	1		
Making life easier	1		
Realistic and measured	1		

To the question, "What is the difference between science and other courses you have studied?", the answers given by the students before and after the implementation were as follows:

Question: What is the difference between science and other courses you have studied?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
Science is linked to other courses	4	Related to current life	4
It is more comprehensive	4	It is more comprehensive	2
It is more fun	3	It is more fun	4
Research is done	3	Exploring	3
Experiments are done	2	Experiments are done	4
Realistic and provable	2	Realistic and provable	3
Science is up-to-date	2	About nature	2
There are creativity and thinking over	1	Observation and investigation	2
There is testing	1	Including research	2
Open-ended expressions are used	1	Being sensible	1
It can change people's point of view on life	1	Based on curiosity	1
		Ways to reach knowledge	1
		Open to progres	1
		Creativity	1
		Including exchange of ideas	1

To the question, "Do you believe that scientists' current knowledge will change in the future?" the answers given by the students before and after the implementation were as follows:

Question: Do you believe that scientists' current knowledge will change in the future?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
Not changeable	10	Changeable	16
Changeable	4		
Some information may change, but not generally	1		
It does not change, but it develops	1		

Question: How do scientists know the existence of living things that lived in the past?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
From fossils	11	Through the excavations with paleontological techniques	14
From the archaeological excavations	9	From fossils	12
By doing research	5	By observing the environment	5
Curiosity	2	By sending frequency with devices	4
Incidentally	2	From the cave pictures	3
Through rumours from people from the past	1	With the help of foot and paw prints	3
With the help of minerals	1	From today's living creatures	3
From fossil fuels	1	From the teeth	1
From footprints	1	By chance	1
With ancient cave paintings	1	From the minerals	1
Through DNA [deoxyribonucleic acids]	1	With imagination	1
From the bodies remaining in the glaciers	1	By analysing cells and DNA	1
With experiments	1	From landforms	1

To the question, "How do scientists know the existence of living things that lived in the past?", the answers given by the students before and after the implementation were as follows:

To the question, "How sure are scientists about the appearance of living things in the past?" the answers given by the students before and after the implementation were as follows:

Question: How sure are scientists about the appearance of living things in the past?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
0–50%	3	0–50%	12
50.00%	1	50.00%	0
50%–75%	4	50%–75%	2
75%–100%	8	75%–100%	2

To the question, "How do scientists who have the same knowledge reproduce different results?" the answers given by the students before and after the implementation were as follows:

Question: How do scientists who have the same knowledge reproduce different results?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
Variety of results	8	The environment of the scientist	9
Thinking styles	5	Thinking styles	9
Different perceptions	4	Evidence is different	5
The environment of the scientist	3	Their imaginations are different	4
Areas of expertise	2		
Research forms	2	Their research is different	3
Differences of knowledge	2	Differences of knowledge	2
Rumour and knowledge by hearsay	1	What they observe is different	2
Scientists' efforts to become famous	1	Their research methods are different	2
Logical reasonings are different	1	Personal characteristics are different	2
		They use different resources	1
		Their training was different	1
		Their experiences are different	1
		Their races and genders are different	1

To the question, "How sure are the weather forecasters about their predictions?" the answers given by the students before and after the implementation were as follows:

Question: How sure are the weather forecasters about their predictions?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
0–50%	0	0–50%	7
50.00%	4	50.00%	4
50%–75%	3	50%–75%	5
75%–100%	9	75%–100%	0

To the question, "Do scientists use their imagination in their study?" the answers given by the students before and after the implementation were as follows:

Question: Do scientists use their imagination in their study?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
No	15	Yes	16
Yes	1	No	0

To the question, "When do scientists use their imagination in their studies?" the answers given by the students before and after the implementation were as follows:

Question: When do scientists use their imagination in their studies?			
Student responses before the implementation		Student responses after the implementation	
Answer	Number of students	Answer	Number of students
They do not use their imagination	15	Throughout their studies	11
At the beginning of the research	1	In the middle of their studies	3
At the beginning of the research	1	At the beginning of the research	2

Discussion

Science centres act as mirrors, they show the development and change of the societies in which they are situated in all aspects, but especially in education, economy and technology (Davis, 2011). The number and content of science centres in a society also show the development of the society. At this point, science centres are milestones for the development of society (Golding & Modest, 2013).

In this study, it was determined that the science centre caused a positive change in the perceptions of middle school students about the nature of science. Individuals who understand science and nature well, understand the connection between the science, technology and economy triangle and contribute to its development. This implies the progress and development of society (Narasimha, 2008). Here, the importance of science centres in societies emerge.

In this study, it was observed that the students' responses to the characteristics of science had changed. Before the science centre visits, students used the terms "Linked to all courses" and "More comprehensive" for the characteristics of science, but after the trips they used the terms "Current", "Fun", "Experiment", "Creativity" and "Open to progress." In the same way, in the study of El Takach (2018), pre-service teachers stated that "Science is related to other courses" for the definition of science in the pre-test, and that "Science is related to daily life" in the post-test.

In our study we found that students' understanding of the scientific definition did not change. The students used the terms "Research" and "Discovery" to define science before and after the implementation. In a study conducted by Tairab (2001), it was concluded that the aim of science for pre-service teachers was to explain and interpret nature.

It was found that there was a positive change in the students' views about the changeability of scientific knowledge. Before the implementation, the majority of students answered "No change" for scientific knowledge. After the implementation, their answers had changed to "It may change." Akerson and Abd-el-Khalick (2005) also determined that the majority of students' scientific knowledge had changed during their studies.

We also observed that students' knowledge about the nature of science based on inferences, had increased. While the majority of the students thought that science was certain and unchanging before the implementation, the students stated after the implementation that it was possible that it could change. Shim, Young and Paolucci (2010) found that inquiry-based science teaching had a positive effect on the nature of conceptions of science based on observations and inferences.

In this study, we observed that students' views on the social and cultural nature of scientific knowledge had developed. While the answers given by the students before the implementation were mostly in the objective dimension, the answers given after the implementation were in the subjective dimension. In a study by Matkins, Bell, Irving and McNall (2002), while all teachers thought that scientific knowledge was not the social and cultural nature in the pre-test, some of the teacher candidates mentioned the social and cultural nature of scientific knowledge after science lessons in which the content was questioned.

In this study we determined that the students' views on the creative nature of scientific knowledge had changed. Similarly, Bell et al. (2003) found that scientific experiments positively affected students' views on the creative nature of science.

Additionally, it was determined that students' opinions about the ways of accessing scientific knowledge showed progress. Also, it was found that the students had established a relationship between dinosaurs and fossils.

In the study by Vaughan (2000), teachers who participated in teacher training programmes based on the nature of science had achieved gains regarding the nature of science in sciences such as mathematics, science and technology. Cochrane (2000) found that students' perceptions of the nature of science developed by applying curricula that included activities aimed at the nature of science. Schellinger, Mendenhall, Alemanne, Southerland, Sampson and Marty (2019) determined that technology-supported project teaching improved elementary school students' views on the nature of science.

The result is our study differ from those in previous studies. We found that the education programmes presented at science centres could be used in science education and that these education programmes could bring about changes in students' perceptions of the nature of science. Students who participated in the science centre education programmes in our study realised after the implementation of the programme that scientists used their imaginations in scientific studies, and that scientists' perspectives, thinking styles and social environment were important in scientific studies. In definitions of science that the students provided after the implementation, actions such as research, curiosity, and discovery were emphasised and creativity came to the fore. In addition, the students realised that science was about daily life and that scientific knowledge was variable, subjective and that its accuracy could not be precise. In addition, they had discovered more accurate methods and techniques of reaching scientific knowledge. These findings are similar to those of other studies (Akerson & Donelly, 2010; Irwin, 2000).

Recommendations

This study was conducted in a limited time. However, when looking at the results obtained in the study, it is clear that the science centre education programmes examined in the study showed the effect of science education – even in a limited time. Similarly, some studies have observed changes in a short time (Chin, 2004; Rennie & Williams, 2002). Long-term studies can be done to generalise the study results.

This study shows that science centres can be used in education on the nature of science education. Based on this result, more trips can be arranged to science centres to learn about the nature of science and more students can attend such science centre education programmes.

The number of students in this study was limited. Future studies with more student participants may be done. Thus, the scope of the study can be expanded. In addition, the science centres and science centre education programmes used in this study were limited. More science centres should be used and different education programmes should be examined.

Authors' Contributions

HE wrote the article and submitted the applications. HE and UÜT conducted all statistical analyses. Both authors reviewed the final article.

Notes

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