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Evaluation of the change in the scientific attitudes of the students participating in the science festival

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Abstract

Science festivals are organizations that aim to raise public awareness on various scientific issues and popularize science. Science Festivals' effects on participants have vital importance. Accordingly, the impact of a science festival supported by the TÜBİTAK 4007 Science Festivals Support program on students' scientific attitudes is discussed. The working group consists of middle and high school students participating in four activities. The data collection tool was the scientific attitude scale. Total attitude scores were compared according to total scientific attitude scores, gender, class level, and whether the participants followed popular science publications and participated in a science camp or scientific research project competition. Results showed a significant difference between the pre-test and post-test scores except for the grade level. Besides, students who did not read popular science books, watched experimental videos, or participated in scientific activities such as a science camp/research project competition experienced a more significant change in their attitude scores. The effects of the activities in the science festivals be organized after that can be determined with mixed-method research. Also, addressing the changes in the curiosity levels of the participants, and examining the long-term effects of the festivals can be effective in increasing these organizations' quality.

Keywords: *Science festivals, TUBİTAK 4007, scientific attitude, popular science book, science camp, scientific research project competitions.*

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Bilim şenliğine katılan öğrencilerin bilimsel tutumlarındaki değişimin değerlendirilmesi

Öz

Bilim Şenlikleri çeşitli bilimsel konularda toplumun farkındalığını arttıran ve bilimi popüler hale getirmeyi amaçlayan organizasyonlardır. Bilim şenliklerinin katılımcılar üzerindeki etkilerini incelemek oldukça önemlidir. Bu nedenle TÜBİTAK 4007 Bilim şenliği destekleme programı tarafından desteklenen bir bilim şenliğinin öğrencilerin bilimsel tutumları üzerindeki etkisi incelenmiştir. Proje süresince dört etkinliğe katılan ortaokul ve lise öğrencileri çalışma grubunu oluşturmaktadır. Veri toplama aracı olarak bilimsel tutum ölçeği kullanılmıştır. Toplam tutum puanları farklı değişkenler ile katılımcıların popüler bilim yayınlarını takip edip etmedikleri, deney videosu izleyip izlemedikleri ve bir bilim kampı ya da bilimsel araştırma projesine katılıp katılmadıklarına göre değerlendirilmiştir. Bulgular sınıf düzeyi haricindeki tüm değişkenlerde öntest ve sontest puanları arasında anlamlı bir fark olduğunu göstermektedir. Bunun yanında popüler bilim kitabı okumayan, deneysel videolar izlemeyen ya da bilim kampı/bilimsel araştırma projesi yarışması gibi bilimsel aktivitelere katılmayan öğrencilerin tutum puanlarında daha büyük değişimler meydana gelmiştir. Bundan sonra düzenlenecek olan bilim şenliklerindeki etkinliklerin etkileri karma yöntem araştırmaları kullanılarak araştırılabilir. Ayrıca katılımcıların merak düzeylerindeki değişimin incelenmesi ve şenliklerin uzun vadeli sonuçlarının araştırılması bu organizasyonların kalitelerinin arttırılmasında etkili olabilir.

Anahtar kelimeler: *Bilim şenlikleri, TÜBİTAK 4007, bilimsel tutum, popüler bilim kitapları, bilim kampları, bilimsel araştırma projesi yarışmaları.*

1. Introduction

Today, the changes in the characteristics of the human power needed and the ways of accessing information cause the perspective of learning environments to be updated [1]. In this context, Ting and Siew [2] emphasize that science teaching can occur outside the four walls and use abundant learning materials outside. Out-of-school learning refers to activities carried out in environments outside of school to improve knowledge, skills, and attitudes [3]. These environments' use in science and social sciences is becoming widespread, and they can create effective learning environments for learning in the affective domain [4]. Increasing the excitement and motivation of the students, increasing their interest and attitude towards the discipline that they learned, helping them gain career awareness, developing their skills in various fields, and increasing their awareness are possible via these environments [5-8]. DeWitt and Storksdieck [9] state that out-of-school learning environments have a short-term effect on students' knowledge. Still, affective effects such as interest, motivation, and attitude towards the relevant field are longer-term. Environments such as museums, nature and science camps, field trips, science centers, botanical/zoos, and aquariums can be out-of-school learning environments. Science festivals can also be crucial out-of-school learning areas for students.

Science festivities are events held at a particular time of the year, usually focusing on a specific theme, whose primary focus is science, technology, engineering, and related fields, and aim to engage non-specialists in scientific content [10]. Science festivals allow the public to meet scientists on various science and health issues. Beyond bringing together individuals of all age groups and scientists, they become an essential source of learning, and they are influential in the career development and planning of the participants. At the same time, they allow scientists to explain their research to the public directly. In science festivals, the public learns important science and society issues such as gene technologies, their understanding of profit-loss, and their moral perspective changes so that the festivals can have a much broader mass effect and the scientific literacy of the participants can improve [11, 12].

Science festivals which gain more importance every day in America and Europe, are also among the scientifically significant organizations in our country [10]. The festivals that include activities where participants are active are more effective, but these organizations have a very high budget. Accordingly, The Scientific and Technological Research Council of Turkey (TUBITAK) Science and Society Department provides budget support with the TUBITAK 4007 Science Festival Support program to the festival organizations. The purpose of the TUBITAK 4007 program is as follows:

> *"4007 - Science Festival Support Program; It aims to disseminate science culture and communication to broader segments of society, convey scientific knowledge to participants, and grasp the interaction between science and technology through activities [13]."*

Studies about the festivals held under the 4007 program reveal participants' preferences. According to these studies, workshop leaders and participants have a positive attitude toward the festival and show a more positive attitude towards the festival as the age group grows [14-16]. The young participants prefer robotics or STEM activities [14,15,17]. Most of the participants either want to go themselves or participate in science festivals with the guidance of their teachers [18]. The results show that both workshop leaders and the public prefer these organizations. Studies also expose some gains for participants. According to some studies held under the 4007 program, the festivals can help participants break down their prejudices [19]. Besides, participants can learn new information, expand their perspectives, trigger their curiosity, be informed about events, deal with technological developments, have fun, learn the areas of use of technology, and develop positive attitudes towards knowledge and nature [18, 20].

In addition to all these, science festivals aim to enable participants to comprehend scientific attitudes [14]. Amintaarti et al. [21] describe scientific attitudes as "a reflection of the development of scientific thinking and skills possessed by students". Students who have scientific attitudes are eager to know and understand. They show patience in the face of difficulties, and they can think in a planned and systematic way in solving problems [22]. These characteristics are pretty essential to gain 21st-century skills. Having scientific attitudes makes students like science, resulting in more learning [23]. Education is a crucial factor in gaining scientific attitudes [24]. Using different teaching strategies, especially student-centered strategies, such as literature and project-based learning [25], problem-based learning with predict-observe-explain [26], robotics activities [27], or inquiry learning model [28-30] can enhance the students' scientific attitudes. Another environment that can affect students' scientific attitudes is science festivals. Workshop leaders generally use active learning or student-centered technics during these organizations. For this reason, these organizations can also enhance participants' scientific attitudes.

Although there are many studies on science fairs [31-40] and science camps [41-50], there are fewer studies on science festivals [51-55] organized in our country. These studies have focused on either the participants' and workshop leaders' opinions [14-16, 18, 51] or the effects of festivals on the participants [19, 20, 53-55]. Studies about festivities organized in other countries report mostly the individuals' characteristics participating in the festivities and their views on the festivities. Park et al. [56] also stated that researchers working in science communication emphasized that science festivals are a bridge between scientists and the public, but when studies on science festivals are examined, there are very few studies on the effects of these organizations. Therefore, the study aimed to determine how a science festival conducted affects the participants' scientific attitudes. Determining the impact of Science Festivals on the participants' scientific attitudes reveals the potential of these organizations to change society's scientific literacy, planning in this direction in the organizations to be organized from now on and influencing the career planning of the younger participants. Also, to see if there were groups interested in science and discuss the attitude differences among these groups, the participants were asked whether they read a popular science book, watched an experiment video, or participated in a science camp research project. In this way, festivities' effects on individuals curious about scientific issues and those who do not will be revealed. The findings obtained will guide the development and implementation of activities suitable for both target audiences in the festivities to be organized. Also, it will be revealed whether individuals who are not interested in scientific subjects can be attracted to science through festivals. Thus, the study will also contribute to the literature containing a small number of studies examining the effects of science festivals.

1.1.Research questions

The research questions of this study are given below:

1. Is there a difference in the science fair participants' scientific attitudes?
2. Is there a difference in the science fair participants' scientific attitudes regarding sub-dimensions of the scale?
3. Is there a gender difference in the science fair participants' scientific attitudes?
4. Is there a difference in the science fair participants' scientific attitudes in terms of class levels?
5. Is there a difference between the participants' scientific attitudes of those who read and who do not read popular science books?
6. Is there a difference between the participants' scientific attitudes who watch and do not watch experimental videos?
7. Is there a difference between the participants' scientific attitudes who participate and do not participate in a project?

2. Methodology

This study aimed to examine the effects of the Project named "Bu sonbahar 10'da Bilim var! (In this autumn, there is science at 10)" and supported by TUBITAK 4007 Science

Festival Support Program on students' scientific attitudes. The Festival was conducted at a science and arts center, organized on 26 and 27 th September 2018 and lasted two days.

2.1 General information about the project

2.1.1 Project's aim

The Project aims to enable the participants to reach the basic science and scientific knowledge concepts. It also aims to make participants have scientific literacy, realize the importance of learning by doing, recognize the fun side of science, and realize the interaction between science and technology.

2.1.2 Project team

There are 10 academicians, 20 teachers, 1 doctor and 2 science communication experts in the project team. Among the specialties of the team members, there are many disciplines, especially science teaching, biology and mathematics (Table 1).

Table 1. Distribution of the project team members' subject matters

Subject matter area	**Frequency**
Science	4
Biology	3
Mathematics	
Primary school teaching	
Arts	2
Chemistry	
Educational sciences	
Geography	
Science communication specialist	
Sports	
Computer teaching	1
Economy	
History	
Literature teaching	
Medicine	
Preschool teaching	
Philosophy	
Social sciences	

The project team consists of people who have participated in this and similar projects before and have experience. 12 member has participated in at least one TUBİTAK 4007 project. Also, some members participated in other science and society projects like science camps or science fairs.

2.1.3 Participants

The project's target audience consists of students at all levels of education and their parents, teachers, and the surrounding community. The activities in the workshops are planned to appeal to more than one teaching level age, as well as to adult groups and teachers. Each workshop leader reported the target audience of each speaker presentation, and the maximum attention was paid to take the records according to the determined target audiences while receiving invitations and participant requests to the events. The number of participants in the workshop recordings made on the project site was 2194.

2.1.4 Intervention

Workshop leaders' suggestions about the target audience were considered while planning the festival schedule, and charts, as in Table 2, were created for each registered school. Thus, it was easier for the activities carried out in the workshops to reach their goals.

Table 2. Sample schedule for a secondary school students

Activity	**Start time**	**End time**	**Place**	**Number of participants**	**School**
Algorithms in our life	13:30	15:00	Hall Sütüven	16 student A group	PLEVNE SECONDARY SCHOOL
Know Yourself Cup	13:30	15:00	Hall Kyzikos	15 student B group	
Learning Through Play	13:30	15:00	Hall Tahtakuşlar	16 student C group	
Have you ever seen a firefly?	13:30	15:00	Hall Ergama	16 student D group	
Algorithms in our life	15:30	16:30	Hall Sütüven	16 student D group	
Know Yourself Cup	15:30	17:00	Hall Kyzikos	16 student C group	
Learning Through Play	15:30	17:00	Hall Tahtakuşlar	15 student B group	
Have you ever seen a firefly?	15:30	17:00	Hall Ergama	16 student A group	

According to the chart in Table 2, 63 students from the relevant secondary school participated in the project. They participated in the workshops given at the Table 2 in 4 groups of 15 or 16 people. Thus, each student participated in 2 workshops. Similar schedules were prepared for all participant schools.
Various workshops and seminars were held during the festival (Table 3).

Participants attended natural sciences, engineering, technology, medical, agricultural, social, and human sciences-related activities (Table 3). Project staff used observation, games, drama, exhibitions, conversations, seminars, group work, experimental work, interactive applications, and competition methods. Thus, participants had experienced scientific knowledge and scientific process enjoyably and understandably. The staff provided the opportunity to learn with fun by avoiding the perception that science is a tedious occupation that is only interested in scientists or has only been taught as a course subject informal educational environments. Activities used during workgroup selection were described in detail below:

Table 3. Workshops and seminars held at the festival and their duration

No	Workshop	Target audience	Activity type	Number of people per workshop	Duration (min)
1	Love-Based Character and Values Education	Teachers and teacher candidates	Seminar	236	70
2	Dance of Drawings on the Möbius Strip	Primary and secondary school students	Workshop	16	60
3	Let's STEM Not To Break Our Eggs	High school students	Workshop	15	180
4	We Make Life Better With Letters	High school students	Workshop	10	60
5	Reading to My Child	Teachers, pre-school children	Workshop	10	90
6	The Language of the Izohips	High school students	Workshop	16	90
7	Algorithms in Our Lives	Secondary and high school students	Workshop	16	60
8	I'm Designing Stamps	Primary and secondary school students	Workshop	16	90
9	Every Child is a Philosopher	Secondary school students	Workshop	15	60
10	Geometry of Turbines	Secondary and high school students	Workshop	10	180
11	Know Yourself Cup	Secondary school students	Workshop	16	90
12	Our Values Topaç -Walnut and Us	General	Workshop	20	60
13	Action: My DNA Necklace	Secondary school students	Workshop	12	90
14	Chariot STEM Mission	General	Workshop	20	90
15	MBOT Bubble Shooter Contest	General	Workshop	8	90
16	Coding and Electronic Circuit Design with MBLOCK	Primary school students	Workshop	9	90
17	I Make Origami	Primary school students	Workshop	16	90
18	Painter Robot Making	Secondary and high school students	Workshop	8	90
19	Game Design with SCRATCH	Secondary school students	Workshop	8	90
20	Historical Rotting Games	General	Workshop	20	60
21	Have You Ever Seen a Firefly?	Secondary school students	Workshop	15	90
22	Waste Free Environment	Primary and secondary school students	Workshop	16	90
23	I'm on a Thief Hunt	Primary and secondary school students	Workshop	16	90
24	Play and Inquiry-Based Science Education for Kids	University students and teachers	Workshop	10	180
25	Learning Through Play	Primary, secondary and high school students	Workshop	15	90
26	I'll take your mind	pre-school children, primary and secondary school students	Workshop	14	90
27	Overview of Students' School Problems	University students	Seminar	328	60
28	What We Didn't Realize Existing and We	General	Seminar	348	60
29	I'm on the team I'm at school	General	Seminar	276	60
30	Ecological Sustainable Economy	General	Seminar	316	60
31	I Write Words Correctly With Wise Box	Primary, secondary and high school students	Workshop	16	60
32	Science Show	General	Exhibition	632	60
33	Tales Mathematics Museum	General	Exhibition	628	180

2.1.4.1 Science show

The activity aims to introduce the fun side of science to children by performing science experiments interactively. For this purpose, it was started with a demonstration experiment in which the frozen foodstuffs were broken when they were tried to be crushed by keeping them in liquid nitrogen. Then, liquid nitrogen was filled into a 1.5 L plastic bottle and thrown into a barrel containing colored balls and hot water. With the sudden expansion of nitrogen into the gas phase, the bottle exploded, and the balls spread around, attracting the audience's attention. Through these experiments, the participants were informed about the state changes. The event was held on the stage, and the necessary precautions for the audience were taken. To give information about chemical reactions, some food coloring and liquid soap were added to the hydrogen peroxide, and potassium iodide was added. Chemical reactions are mentioned as a result of the foams. The starch was taken into a pipe with a funnel and blown on the burning torch to demonstrate the contact surface effect on the reaction rate. Finally, a water rocket was created, and the working principle of rockets was mentioned.

The event was held in 60-minute sessions for two days, and students were allowed to watch it in groups of 80 people.

2.1.4.2 Tales mathematics museum

In addition to mathematics in daily life, the event aimed to enable individuals to touch mathematics by making mathematics concrete rather than abstract, with stations suitable for the Ministry of National Education curriculum. During the activity, mathematical subjects were narrated, and theorems were tried to be proved logically. The importance of generating new ideas by thinking freely about the problems was understood. It was ensured that they understood by living that there could be different solutions in the solution of a problem. By touching on mathematics, it was tried to increase the love of mathematics without putting any limits on mathematics. It was tried to raise the awareness of visiting museums among the participants.

In the event, museum activities were visited in groups of 20 people.

2.1.4.3 Let’s STEM not to break our eggs

The activity aimed to enable students to learn about air pressure and friction force by doing and experiencing. In this process, biology, engineering, mathematics, and values education were also associated, and it was tried to enable students to think multidimensionally and interdisciplinary and enjoy science. The students were asked to set up a mechanism so that the egg given to them would reach the ground without breaking when thrown from the second floor. The materials they will use while doing this have prices, and the cost of the assembly to be created should be minimal. The groups made their carriers and threw them from the specified height, and among the groups whose eggs were not broken, the group that cost the carrier the least won. The activity was implemented in 180-minute sessions with groups of 15 people over two days.

2.1.4.4 Geometry of turbines

The workshop aimed to raise awareness about energy types, energy conversion, and wind from renewable energy sources. At first, brainstorming was conducted on non-renewable, renewable energies and their effects on the environment. The students were asked to question non-renewable energy types and why this type of energy should be abandoned. Then, the students researched wind energy and the technologies used in wind energy. Finally, the students were asked to design the blades they would use in the turbine to make the most efficient use of wind energy. Participants created their wings in the 3D

program by researching different geometric shapes, and the designed wings were printed out from the 3D printer. Finally, they mounted the blade designs on DC motors and tested how many volts their blades could produce in the wind outside. By looking at the measurement results, it was determined which wing design produced more energy. They were asked to calculate the areas of the geometric shapes of the wings they created and to discuss which geometric shape had the highest voltage. Thus, the efficiency of the blades used in today's technology and the advantages and disadvantages of different blade designs are discussed.
The event was held in 180-minute sessions with groups of 10 people over two days.

2.1.4.5 Action DNA necklace

This activity aimed for the participants to observe DNA, the leading molecule in the cell. First, the participants were asked to enter https://www.mentimeter.com/ and write down what comes to mind when they say DNA. DNA was discussed over the concepts seen in the word cloud prepared on the site in line with the answers. The students found the location of the experiment materials by performing the tasks created in the application called Actionbound and then proceeded to the experimental part. The groups crushed the fruits given to them and added the liquid dish soap, salt, and tap water mixture they had prepared in a beaker to the bag. They closed the bags' mouths, crushed them some more, and filtered the mixture in the locked bag with the help of a funnel and strainer into a measuring tape. They separated the remaining solid particles after slowly adding cold ethanol to the filtrate. A cloud-lik
e white gel-like layer formed on the upper ethanol layer, thus obtaining the DNA of the fruit. The participants placed DNA samples on the necklaces given to them using a Pasteur pipette and put the necklaces around their necks. The workshop leader explained DNA's structure at the end of the session, and the gains of the groups in the study were evaluated with the Kahoot application.
The event was held in groups of 12 for two days in 90-minute sessions.

2.1.4.6 Chariot STEM mission

The purpose of the event was to show for what purposes chariots have been used throughout history and enable participants to design their unique two-wheeled chariots with simple materials and robotic cannons. Pictures of the use of two-wheeled cars in history were shown to all participants, and a discussion was held. After giving information about the programming, operation, and engineering design cycle, the students were asked to design a two-wheeled car that would complete the racetrack in the shortest time by using Sphero robotic balls. The students finished their designs and programming within the time given to them, and at this stage, they tested their prototypes by experimenting on the track. Then all groups competed by placing their two-wheeled car designs at the track's starting point, and the event was concluded by making a verbal evaluation of the event.
The event was held for two days with 90-minute sessions and groups of 20 students.

2.1.4.6 Electronic circuit design with MBLOCK

The activity aimed to develop students' algorithm creation, programming, and problem-solving skills. First, workshop leader introduced coding, Ardunio, and other equipment with the workshop leader MBlock. Then he asked the students to create the algorithm and transfer it to the Arduino card by coding with Mblock. After the students completed their coding, they checked whether their programs were working or not. The workshop leader asked guiding questions to identify the points where mistakes could be made if the circuit did not work and the circuits were made to work. The activity was applied to groups of 9 people in 90-minute sessions over two days.

2.2 Workgroup

Researchers used criterion sampling methods from purposeful sampling methods. The workgroup consisted of individuals who met this sampling method's criteria [57]. Criterion sampling is suitable especially for studies that deal with an educational program [58]. Because researchers desired to examine the effects of the activities applied during the project process on the participants' scientific attitudes, they decided to determine the study group using the criterion sampling method. Therefore, students who participated in four activities during the project were included in the workgroup. All students attended the science show and the Thales mathematics museum. Additionally, they attended two workshops named Chariot STEM Mission, Let's STEM to Not Break Our Eggs, Action DNA Necklace, Coding and Electronic Circuit Design with MBLOCK, Geometry of Turbines. The number of participants for each workshop is given in Table 4, and the characteristics of the participants are shown in Table 5.

Table 4. Number of participants for each workshop

<table>
<tr><th>Workshop</th><th>Number of participants</th><th>Explanation</th></tr>
<tr><td>Science show</td><td>121</td><td rowspan="2">All astudents attended these workshops</td></tr>
<tr><td>Tales mathematics museum</td><td>121</td></tr>
<tr><td>Let's STEM Not to Break Our Eggs</td><td>60</td><td rowspan="2">60 students attended these two workshops</td></tr>
<tr><td>Action DNA Necklace</td><td>60</td></tr>
<tr><td>Coding and Electronic Circuit Design with MBLOCK</td><td>61</td><td rowspan="3">61 students attended two of these three workshops.</td></tr>
<tr><td>Chariot STEM Mission</td><td>36</td></tr>
<tr><td>Geometry of Turbines</td><td>25</td></tr>
</table>

Table 5. Distribution of the sample group by school, class, and gender

<table>
<tr><th rowspan="2">Class</th><th colspan="2">Gender</th><th rowspan="2">Total</th></tr>
<tr><th>Girl</th><th>Boy</th></tr>
<tr><td>5</td><td>17</td><td>12</td><td>29</td></tr>
<tr><td>7</td><td>21</td><td>17</td><td>38</td></tr>
<tr><td>9</td><td>17</td><td>16</td><td>33</td></tr>
<tr><td>10</td><td>13</td><td>8</td><td>21</td></tr>
<tr><td>Total</td><td>68</td><td>53</td><td>121</td></tr>
</table>

During the scale's implementation, the students were asked whether they read a popular science magazine or book, watched a documentary or demonstration, and participated in any science and society project (such as TÜBİTAK 4004-4006) or a project competition. According to the answers obtained, the distributions are given in Table 6.

Table 6. Participants' interest in scientific issues

Gender	Class	Read		Do not read		Watch		Do not watch		Participate		Do not participate	
		f	%	f	%	f	%	f	%	f	%	f	%
Girl	5	11	64.7	6	35.3	11	64.7	6	35.3	3	17.6	14	82.4
	7	17	81.0	4	19.0	17	81.0	4	19.0	6	28.6	15	71.4
	9	12	70.6	5	29.4	13	76.5	4	23.5	5	29.4	12	70.6
	10	9	69.2	4	30.8	11	84.6	2	15.4	4	30.8	9	69.2
	Total	49	72.1	19	27.9	52	76.5	16	23.5	18	26.5	50	73.5
Boy	5	6	50.0	6	50.0	9	75.0	3	25.0	1	8.3	11	91.7
	7	14	82.4	3	17.6	15	88.2	2	11.8	6	35.3	11	64.7
	9	9	56.3	7	43.7	10	62.5	6	37.5	4	25.0	12	75.0
	10	7	87.5	1	12.5	6	75.0	2	25.0	4	50.0	4	50.0
	Total	36	67.9	17	32.1	40	75.5	13	24.5	15	28.3	38	71.7
Total	5	17	58.6	12	41.4	20	69.0	9	31.0	4	13.8	25	86.2
	7	31	81.6	7	18.4	32	84.2	6	15.8	12	31.6	26	68.4
	9	21	63.6	12	36.4	23	69.7	10	30.3	9	27.3	24	72.7
	10	16	76.2	5	23.8	17	81.0	4	19.0	8	38.1	13	61.9
	Total	85	70.2	36	29.8	92	76.0	29	24.0	33	27.3	88	72.7

70.2% of the participants stated that they read a popular science book or magazine, while 29.8% did not. Depending on the gender, 72.1% of the girls and 67.9% of the boys stated that they read scientific publications. Responses about watching experimental videos were similar. This situation shows that most participants are interested in science and scientific subjects. However, when asked whether they had participated in any project before, most stated they did not participate (girls 73.5%, boys 71.7%, and generally 72.7%; Table 6).

The researchers informed the participants about the content of the scale applied and stated that they may not want to participate or leave it unfinished if they encountered questions they did not want to answer while filling out the scale. Also, to prevent the Hawthorne or Halo effect [59, 60], the researchers applied the scales during other workshop leaders' activities and worked with participants who did not participate in their activities. In addition, throughout the project, the workshop leaders were not told whether there would be a change in scientific attitudes as the project's output. Thus, the leaders were prevented from exhibiting behaviors that would mainly affect the scientific attitude in their workshops.

2.3 Data collection tool

The data collection tool was The Scientific Attitude Scale, developed by Moore and Foy [61] and adapted by Demirbaş and Yağbasan [62]. Permission was obtained from the relevant researchers to use the scale. The scale consists of 40 items (20 positives and 20 negative items) in a five-point Likert type (strongly disagree, disagree, undecided, agree, and strongly agree). There are six sub-dimensions on the scale. These sub-dimensions are related to the nature of science and participants' feelings towards science. Sub-dimensions' titles and related item numbers are as follows: scientific laws and theories' structure (4, 11, 15, 16, 34, 35), structure of science and approach to events (2, 7,10, 19, 26, 33), exhibit scientific behaviour (3, 5, 17, 18, 25, 32), structure and purpose of science (9, 20, 21, 24, 28, 31), the place of science in society and importance (6, 8, 12, 23, 29, 38) and willingness to undertake scientific studies (1, 13, 14, 22, 27, 30, 36, 37, 39, 40). The item-total correlations ranged between .30 and .49, and the t-values were significant [62]. Besides, the Cronbach alpha coefficient was found as .76 [62]. Since the value found is more significant than .7, it can be reliable [63]. In this study, the Cronbach alpha coefficient of the scale was found as .741.

Goodboy and Martin [64] state that the Cronbach alpha coefficient is widely used to determine reliability, but the assumptions required to use this value are ignored. They emphasize that it would be healthier to use McDonald's omega coefficient to determine reliability. For this reason, McDonald's omega value was calculated using the SPSS macro developed by Hayes [65], and the value was found to be .766.

Attitude scale was implemented to the participants as pre-test before they attended the first workshop they enrolled in. After they participated in all workshops, they enrolled, and the same scale was implemented as a post-test.

2.4 Data analysis

The data obtained from the study were analyzed using the SPSS 25 package program. Participants' responses to positive items were scored between 1 (strongly disagree) and 5 (strongly agree), and reverse conversion was made for negative items. There was no missing data. Kolmogorov-Smirnov test, the ratio of skewness and kurtosis coefficients to standard deviations, and the normal Q-Q curve were used to determine normality. According to the Kolmogorov-Smirnov test, pre-test and post-test total scores (for both test $p = .200$) showed normal distribution ($p <.05$), but scores of sub-dimensions did not. However, each sub-dimension ratio skewness coefficient and kurtosis coefficient divided by their standard deviations and ratios found were in the range of $\pm$ 1.96 (Table 7). The expected and actual values in the standard Q-Q curves are also distributed close to the 45-degree line. For these reasons, these data were accepted as normally distributed [66]. T-tests and ANOVA were used to analyze the data.

Table 7. Skewness and kurtosis values for sub-dimensions

Sub-dimension	**Pre-test**						**Post-test**					
	Skewness	**SE**	**Ratio**	**Kurtosis**		**Ratio**	**Skewness**	**SE**	**Ratio**	**Kurtosis**	**SE**	**Ratio**
Scientific laws and theories' structure	-.058	.220	**-.264**	.047	.437	**-.108**	-.420	.220	**-1.91**	.869	.437	**1.988**
Structure of science and approach to events	-.075		**-.341**	-.190		**-.435**	.134		**.609**	.268		**.613**
Exhibit scientific behavior	-.255		**-1.16**	-.322		**-.738**	-.322		**-1.46**	.092		**-.210**
Structure and purpose of science	-.112		**-.509**	.296		**.677**	-.017		**-.077**	-.122		**-.279**
The place of science in society and its importance	.154		**.700**	-.310		**-.709**	-.023		**-.104**	-.062		**-.142**
Willingness to undertake scientific studies	-.140		**.636**	-.567		**-1.30**	.165		**.750**	-.546		**-1.25**
Total	.013		**.059**	-.283		**-.648**	-.135(.220)		**-.614**	-.260(.437)		**.595**

3. Findings

3.1 The impact of the project on the participants' scientific attitudes

The scientific attitude scale adapted by Demirbaş and Yağbasan [62] was applied to reveal the change in the scientific attitudes of the Project's participants. A paired sample t-test was performed for the relevant samples to determine the Project's effect on the participants' scientific attitudes, and the findings obtained are given in Table 8.

Table 8. Comparison of the scientific attitude scale total scores of the participants

Measurement	N	$\bar{X}$	S	Sd	t	p	η^2
Pre-test	121	142.72	12.46	120	-3.41	.001	.088
Post-test	121	146.80	11.18				

According to Table 8, there was a statistically significant increase in total scientific attitude scores from pre-test [$\bar{X}$= 142.72, S= 12.46] to post-test [$\bar{X}$= 146.80, S=11.18, t(120)=-3.41, p<.05]. The eta squared statistic was calculated as .088, and this value shows that the difference has a moderate effect [63].

The scale used has six sub-dimensions. Table 9 compares the participants' scores according to each sub-dimension.

Table 9. Comparison of the scores the participants got from the sub-dimensions of the attitude scale

Sub-dimension	Measurement	N	$\bar{X}$	S	Sd	t	p	η^2
The structure of scientific laws and theories	Pre-test	121	19.49	2.66	120	-2.88	.005	.065
	Post-test	121	20.32	2.10				
The structure of science and how it approaches to events	Pre-test	121	21.89	3.18	120	-.88	.378	
	Posttest	121	22.23	2.68				
Demonstrate scientific behavior	Pre-test	121	22.38	3.45	120	-2.56	.012	.052
	Post-test	121	23.37	3.28				
The structure and purpose of science	Pre-test	121	18.87	1.97	120	-2.82	.006	.062
	Post-test	121	19.50	1.87				
The place and importance of science in society	Pre-test	121	22.60	2.90	120	.347	.729	
	Post-test	121	22.48	2.98				
The structure of scientific laws and theories	Pre-test	121	37.50	5.62	120	-2.60	.010	.053
	Post-test	121	38.89	5.13				

The evidence showed a statistically significant increase in all sub-dimensions except the "Structure of Science and the Way of Approaching to Events" and "The Place and Importance of Science in Society" sub-dimensions. The effect sizes for the differences found showed that it had a moderate effect for the "Structure and Purpose of Scientific Laws" and "The Structure and Purpose of Science" sub-dimensions (eta square values respectively, η^2 =.065 and 062) and a low level of effect in the "Demonstrating Scientific

Behavior" and "Willingness to Do Scientific Studies" sub-dimensions (η^2 =.052 and 053, respectively).

3.2 Examining the change in participants' scientific attitudes by gender

The data obtained according to participants' gender were examined separately, and the pre-test and post-test data were compared using the paired sample t-test for each group. The findings obtained are given in Table 10.

Table 10. Results of the paired sample t-test based on the gender of the participants

Gender	Measurement	N	$\bar{X}$	S	Sd	t	p	η^2
Girl	Pre-test	68	142.85	12.38	67	-3.58	.001	.161
	Post-test	68	148.85	11.27				
Boy	Pre-test	53	142.56	12.68	52	-.985	.329	
	Post-test	53	144.17	10.60				

As a result of the paired sample t-test, there is a statistically significant difference between the girls' pre-test[$\bar{X}$= 142.85, S = 12.38] and post-test [$\bar{X}$= 148.85, S = 11.27, t (67) = -3.58, p <.05, η^2=.161] scores in favor of the post-test, and since the effect size of this difference is> .14, it has a large effect.

An independent samples t-test was conducted to compare the pre-test and post-test scores of female and male students and given in Table 11.

Table 11. The independent samples t-test results for the female and male participants' scores

Measurement	Gender	N	$\bar{X}$	S	Sd	t	p	η^2
Pre-test	Girl	68	142.85	12.38	119	.125	.901	
	Boy	53	142.56	12.68				
Post-test	Girl	68	148.85	11.27	119	2.327	.022	.04
	Boy	53	144.17	10.60				

There was no difference for pre-test scores based on gender, while a significant difference was found in favor of females' post-test scores. When the effect size is calculated, the eta squared value was .04, which shows that their difference has a negligible effect [63].

3.3 Investigation of the change in participants' scientific attitudes by class level

Researchers considered participants' class levels separately and performed paired sample t-test (Table 12). Only 9th-grade students' pre-test and post-test scores were statistically significant. Since this difference's effect size is .25, it can be said that the difference has a significant effect [63].

One-way ANOVA statistics were used to compare different class levels' pre-test and post-test scores. Mean scores regarding class level are given in Table 13, and the ANOVA results are given in Table 14. ANOVA results showed a statistically significant difference between grade levels at the p <.05 level. The effect size for this difference was calculated as .13, indicating that the difference is medium. Post-hoc analyses were carried out using the Scheffe test because the sample numbers in the groups were different. A statistically significant difference between 5th and 7th grades was found.

Table 12. Related sample t-test results of the participants according to their grade levels

Class	Measurement	N	$\bar{X}$	S	Sd	t	p	η2
5	Pre-test	29	135.90	12.71	28	-1.399	.173	
	Post-test	29	140.03	13.29				
7	Pre-test	38	147.63	10.17	37	-.850	.401	
	Post-test	38	149.34	10.55				
9	Pre-test	33	141.97	13.78	32	-3.253	.003	.25
	Post-test	33	149.24	10.16				
10	Pre-test	21	144.48	9.64	20	-1.466	.158	
	Post-test	21	147.71	6.52				

Table 13. Mean scores according to grade levels

Class	N	$\bar{X}$	S
5	29	135.90	12.71
7	38	147.63	10.17
9	33	141.97	13.78
10	21	144.48	9.64

Table 14. ANOVA results regarding the comparison of pre-test results according to grade levels

Source	SS	df	Mean Square	F	p	Differences	η2
Between groups	2350.260	3	783.420	5.627	.001	5-7	.13
Within groups	16289.740	117	139.229				
Total	18640.000	120					

Table 15 shows the mean scores for the comparison of the post-test scores. Researchers analyzed the variances' homogeneous distribution before the ANOVA analysis. The variances for the pre-test scores showed homogeneity but not for the post-test scores. For this reason, Welch and Brown-Forsythe tests were performed in the post-test scores. Games-Howell test was used in the post-hoc analysis (Table 16).

Table 15. Mean scores for the comparison of post-test results according to grade levels

Class	N	$\bar{X}$	S
5	29	140.03	13.29
7	38	149.34	10.55
9	33	149.24	10.16
10	21	147.71	5.52

According to Welch's ANOVA statistics, there is a statistically significant difference between the classes' post-test scores [F (3, 62.710) = 3.687, p <.05]. Post-Hoc analysis showed that this difference was between fifth graders and seventh, ninth, and tenth grades, in favor of 7th, ninth and 10th grades, respectively.

Table 16. Welch and Brown-Forsythe test results

Test	Statistics	Df1	df2	p	Differences	Cohend
Welch	3.687	3	62.710	.016	5-7	.78
Brown-Forstythe	5.570	3	99.027	.001	5-9 5-10	.78 .73

3.4 Investigation of the effect of participants' popular science publication readings on the change in scientific attitudes

The difference between the pre-test and post-test scores of the participants who read science and technical journals or books based on scientific subjects and those who did not were examined (Table 17).

Table 17. Paired sample t-test results about the participants' who read and do not read popular science publications scores

Group	Measurement	N	$\bar{X}$	S	Sd	t	p	η2
Read	Pre-test Post-test	85 85	145.43 148.86	12.09 10.11	84	-2.464	.016	.067
Do Not Read	Pre-test Post-test	36 36	136.33 141.94	11.04 12.20	35	-2.418	.021	.143

Paired sample t-test results showed a statistically significant difference between the pre-test [$\bar{X}$= 145.43, S=12.09] and post-test scores [$\bar{X}$= 148.86, S=10.11; t(84)=-2.464, p<.05] of the participants in both groups in favor of the post-test. The effect size (η^2 = .067) of the participants, who read the popular science publication, score comparison shows a moderate effect (<.06). In contrast, the effect size of the non-reading groups' scores shows a significant effect (<.14) [63].

The difference between the groups' scores was examined with the unrelated sample t-test (Table 18). When the pre-test scores were compared, there was a statistically significant difference between the two groups in favor of the reading group. This difference's effect size was calculated as .112, and this value shows that the difference has a moderate effect. Again, there is a statistically significant difference between the groups' post-test scores, and this difference's effect size (η^2= .08) has a moderate effect [63].

Table 18. Independent sample t-test results comparing the pre-test and post-test scores of the participants who read and did not read the popular science publication

Measurement	Group	N	$\bar{X}$	S	df	t	p	η2
Pre-test	Read	85	145.43	12.09	119	3.882	.000	.112
	Do not read	36	136.33	11.04				
Post-test	Read	85	148.86	10.11	119	3.229	.002	.08
	Do not read	36	141.94	12.20				

3.5 Investigation of the effect of participants' watching experiment videos on the change in scientific attitudes

The pre-test and post-test scores of the participants who watched and did not watch the experimental videos were considered separately, and their scores were compared with the related sample t-test (Table 19).

Table 19. Related sample t-test results according to watching experimental videos

Group	Measurement	N	$\bar{X}$	S	Sd	t	p	η2
Watched	Pre-test	92	144.44	12.56	91	-2.550	.012	.067
	Posttest	92	147.79	10.76				
Did not watch	Pre-test	29	137.27	10.60	91	-2.335	.027	.162
	Post-test	29	143.66	12.09				

There is a statistically significant difference between the pre-test [$\bar{X}$=144.44, S=12.56] and post-test [$\bar{X}$=147.79, S=10.76; t(91)=-2.550, p<.05] scores for participants who watched the experimental videos in favor of the post-test. The effect size (η^2=.067) indicates a moderate effect. Evidence shows a statistically significant difference in favor of the post-test between the participants who did not watch videos. According to the calculated effect size (η^2=.162), this difference has a significant effect [63].

When the groups compared with each other, there was a statistically significant difference in favor of the watched group [$\bar{X}$=137.27, S=10.60; t(119)=2.776, p<.05; η^2 =.06]. However, evidence showed no difference between the post-tests (Table 20).

Table 20. Comparison of participants who watched the experimental videos and did not

Measurements	Group	N	$\bar{X}$	S	Sd	t	p	η^2
Pre-test	Watched	92	144.44	12.56	119	2.776	.006	.06
	Did not watched	29	137.27	10.60				
Post-test	Watched	92	147.79	10.76	119	1.753	.082	
	Did not watched	29	143.66	12.09				

3.6 Investigation of the effect of participants' participation in any project on the change in scientific attitudes

Participants were asked whether they have participated in any TUBITAK projects or TUBITAK project competitions for secondary and(or) high school students. The findings of this question are in Table 21. There was no statistically significant difference between the pre-test and post-test scores of the students who had participated in any project before. Evidence shows a statistically significant difference between the pre-test and post-test scores of the students who did not participate in favor of the post-test. The effect size was .08, and this value indicates a medium effect [63].

Table 21. Comparison of the participants' scores according to project participation

Group	Measurement	N	$\bar{X}$	S	Sd	t	p	η2
Attend	Pre-test	33	146.70	10.36	32	-1.927	.063	
	Post-test	33	150.67	8.99				
Do not attend	Pre-test	88	141.24	12.90	87	-2.827	.006	.08
	Post-test	88	145.35	11.62				

Two groups' comparisons with each other are given in Table 22. Evidence from pre-test scores shows a statistically significant difference in favor of the participants included in a Project [t(119)=2.179, p<.05; η^2 =.038]. Also, participants involved in the project post-test scores significantly differ from participants who did not attend any project [t(119)=2.373, p<.05; η^2 =.045]. Effect size values show that the differences have a negligible effect [63].

Table 22. Comparison of the participants' pre-and post-test scores according to project participation

Measurement	Group	N	$\bar{X}$	S	Sd	t	p	η2
Pre-test	Attend	33	146.70	10.36	119	2.179	.031	.038
	Do not attend	88	141.24	8.99				
Post-test	Attend	33	150.67	12.90	119	2.373	.019	.045
	Do not attend	88	145.35	11.62				

4. Discussion

Although out-of-school learning environments have short-term effects on individuals' cognitive structures, they can have long-term effects on motivation and attitudes towards the relevant learning area [9]. One of these learning environments is science festivals, and in this study, the impact of science festivals on the participants' scientific attitudes was examined. It was determined that there was an increase in the participants' scientific attitudes in general. However, "the structure of science and its approach to events" and "the place and importance of science in society" sub-dimensions have not change. The most crucial reason underlying this may be the workshops in which the participants were involved. All the participants attended the Tales mathematics museum event and a science show. In these workshops, participants watched interesting demonstration experiments and math demonstrations. These activities may have increased their willingness to do scientific work. Participants also attended generally STEM-related workshops, and as can be read about related activities explanations, These workshops' objectives include encouraging interdisciplinary and multidimensional thinking and understanding of specific subject areas. They are practice-oriented, and the approach of science to events and the relationship between science and society are not emphasized in these workshops. This may have hindered the development of the participants' attitudes towards these dimensions. Şahin [20] stated that the 10th-grade students who attended the science festival had a positive effect on their attitudes towards the chemistry course. In contrast, Akkanat [28] noted that the students developed a positive attitude towards the science festival. These findings obtained from this aspect are supported by Şahin [20] and Akkanat [51].

A significant difference was found between female students' pre-and post-test scores. In addition, while there is no significant difference between the pre-test scores of female and male students, a significant difference was found between the post-test scores, which has a negligible effect. Studies in the literature show that scientific attitudes are not dependent on gender [67, 68]. The fact that there was no difference between the pre-tests is similar to these studies. However, the post-test scores show that female students were slightly more affected by the Project than male students.

According to the grade levels, only a difference in favor of the 9th-grade students' post-test scores. However, evidence showed an increase in all groups' scores, although it was not significant. When different grade levels' pre-test scores were compared, only a difference between 5th and 7th grades in favor of 7th grade was found. A difference was found between 5th grades and 7th, 9th, and 10th grades in favor of 7th, 9th, and 10th grades' post-test scores. This finding shows that the activities in the Project are more effective in older age groups. Grade 5 students may have seen the workshops in the Project more for entertainment and applied them without thinking about it. However, older age groups may have attended more consciously as they were more clearly aware of the events and realized their opportunity. This awareness may have caused a more significant increase in the attitudes of 7th, 9th, and 10th-grade students compared to 5th grade. A similar finding was expressed by Başar et al. [13], and it was stated that the attitude towards the festival increased depending on the age group.

The participants were asked whether they watched experiment videos in various social media tools, read a popular science book, participated in a science camp or research project competition to determine whether there were individuals with a particular interest in scientific issues. By considering the sample group, it is seen that most of the participants read a popular science book or watch an experiment video but do not participate in a project. This data shows that students are interested in scientific subjects but not actively involved in scientific activity. Kennedy et al. [69]stated in their studies that people who are already interested in science or have a particular curiosity about a subject generally attend science festivals. Evia and Peterman [70] determined that individuals participating in science festivities gather in three groups: amateurs, enthusiasts, and uninterested ones. According to this classification, individuals who are interested in science and have a hobby related to science are grouped as amateurs, individuals who are only interested in science as curious, individuals who express that they are not interested in science and that they only come to participate in an activity are grouped as indifferent. In this study, individuals who participated in a science camp or project contest can be grouped as amateurs since they have studied in a specific field of science, individuals who read a popular science book or watch an experiment video as curios, and individuals who do not do any of these as uninterested.

The findings of individuals who read a popular science book were described as curious, and individuals who did not (outside the group) were examined. A significant difference was found between the pre-test and post-test scores of both groups, and the effect size of the group who did not read was more significant than the reading group. This result shows that the activities in the Project had a more pronounced effect on the attitudes of students who are not interested in popular science topics. However, the students' change in popular science subjects' attitude scores shows that the activities in the Project also had a significant impact on this group: a difference in favor of the reading group was found between the pre-test and post-test scores. However, the difference between pre-test scores is more significant than post-test scores. These findings show that the difference between the two groups decreased after the Project. The group that was not interested in popular science subjects also started to exhibit a positive attitude towards science.

Findings regarding the students' who watched and did not watch the experiment video attitudes show a significant increase in favor of the post-test scores between the pre-test and post-test scores of the students in both groups. Like the findings obtained in popular science publications, the effect size of the group that did not watch the experiment video was calculated as more significant than the group that watched it. However, unlike the comparison of the groups that read and did not read the popular science book, there was a significant difference between the two groups' pre-tests in favor of the students watching the experiment video. Still, no difference was found between the two groups after the Project. This finding shows that watching the demonstration experiment has a more negligible effect on scientific attitudes than reading a popular science book.

According to the studies of Evia and Peterman [70], when the participants' data, who can be considered amateur, were examined, no significant difference was found between the pre-test and post-test scores. This finding shows that students' activities significantly impact their scientific attitudes, such as science fairs/science camps. Indeed, Durmaz et al. [71] state that the science fair/festival where students present their projects significantly impacts their scientific attitudes. The amateur and unrelated groups' comparison shows a difference between both pre-test and post-test scores, which was in favor of the amateur group. According to the variable of reading popular science books groups, a similar finding was found. However, considering the video watching variable, it is seen that the difference between the two groups is closed in the post-test. These findings show that students' reading about scientific subjects or participating in projects significantly affects scientific attitudes. There was a significant difference between the unrelated group's pre-test and post-test in terms of all variables. It is noteworthy that the festival's effect is more significant, especially in the video viewing variable, and the difference between the curious group is closed. All these data show that participating in the science festival helps students who are not interested in scientific subjects to develop a positive attitude.

5. Conclusion

Today, the survival and development of societies depend on the effects they create in science and technology. For this reason, in addition to the acquisition of 21st-century skills in education systems, it is one of the essential points to raise scientifically literate individuals. The prerequisite for raising scientifically literate individuals is that individuals have a positive attitude towards science. It may not be possible to develop attitudes in the affective field only informal education. Various out-of-school learning environments such as museums, science camps, and science centers also contribute to developing a positive attitude towards science. Another out-of-school learning environment that will contribute to the development of a positive attitude towards science is the science festival, which aims to introduce and endear science branches to all segments of the public. Organizing festivals that will improve the perspectives of individuals on science and scientific issues can also contribute to the increase of the scientific literacy level of society. In this study, "Science is in 10 this autumn!" The

Science festival's effect on participants' scientific attitudes has been examined, and it is hoped that it will serve as a guide for the festivities to be organized from now on.

An overall increase in the participants' scientific attitudes toward participating in the science festival was determined in the study. The study shows that students who cannot participate in various scientific activities, who are unaware of such activities, and who do not allocate too much time to interdisciplinary study at their school can develop a positive attitude towards science by attending such activities. Similar effects are acceptable for those who do not read books on scientific subjects or watch documentaries due to the impossibility or the lack of family guidance can develop a positive attitude towards science. Furthermore, it shows that such projects can effectively increase their interest.

The most significant limitation of this study is that it was studied with the data obtained from the students who participated in 4 activities. The most important reason for making such a limitation is that attitude change is a problematic element. Since a significant difference cannot be expected in the students participating in a single workshop, student groups participating in the maximum number of workshops were determined during the festival. In addition, the large number of participants and the fact that the participant groups participated in the activities in different numbers made it difficult to apply the scale to all participants.

6. Implications

In this study, the participants' attitudes who participated in four activities at the science festival were discussed, and the changes in scientific attitudes were examined based on only quantitative findings. In future studies, regardless of the number of activities, all participants involved in the Project can be examined, and the effects of science festivals on scientific attitude can be discussed in more depth by adding mixed-method research and qualitative data collection tools.

In addition, the short-term results of the festival were discussed in the study. The tests can be re-applied after a certain period, and the long-term effects can be examined. In this study, students and adults participated in separate groups. However, Tuttle et al. [72] state that students' inference skills are better developed in out-of-school learning activities with their parents. Science festivals can also be influential in providing these environments. Science activities with parents can organize, and their effects can be compared in terms of both adults and students.

Even if science festivals do not change the participants' attitudes, they may cause the development of their curiosity and the differentiation of their related fields. In future studies, what kind of effect science festivals have on participants' feelings of curiosity can be examined. In addition, science festivals are places where students of different age groups get the chance to meet with people from different professions at the same time. In this respect, during the festivals, individuals from different professions who have workshops and conversation activities can be organized to get information about their profession by organizing conversations.

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Kaynaklar

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