MOJES MALAYSIAN ONLINE JOURNAL OF EDUCATIONAL SCIENCES JULY 2019, 7 (3)

THE IMPACT OF SCIENCE FAIRS ON ADULTS' SCIENTIFIC PERCEPTIONS & SCIENTIFIC EPISTEMOLOGICAL BELIEFS

Hakan TÜRKMEN
Ege Üniversitesi, Eğitim Fakültesi
hakan.turkmen@ege.edu.tr

ABSTRACT

Scientific epistemological beliefs reveal the philosophical understanding of the science subjects about the meaning, producing and sharing processes of scientific knowledge. It is important to use informal environments, museums, science centers, natural parks, aquariums, all kinds of natural area, during science teaching, because students interact with nature and natural phenomena by acting like scientists. Moreover, teachers can easily follow whether students use scientific processes and try to find solutions to problems by using these processes. One of the informal learning environments is Science Fairs which are public exhibitions where students expose their projects to visitors. Students develop their research skills, critical thinking skills and positive attitudes toward science during the science fair. The study was conducted to examine the changes in the scientific epistemological beliefs of adults participating in the 12 science fairs held on different days in the province of Bornova in Izmir and their views on the science fair as informal teaching environment. The sampling group consisted of 92 individuals (69 female, 23 male) selected from the people visited to science fair by random sampling method. The results were analyzed using quantitative and qualitative data collection tools. The research design is a single group pretest - posttest design. The Scientific Epistemological Beliefs Scale, consisting of 30 items of 5 Likert type, was applied to participants. Whether or not there was a statistically significant difference in the opinions before and after the Science Fair was analyzed with the SPSS package program. Then 2 people from each science fair selected randomly from 12 science fairs for interview. 4 adults changed their mind to interview. Twenty were interviewed with 4 questions that the researcher prepared and developed via 3 different expert opinions. The results were evaluated using descriptive analysis. According to the results, there was no statistically significant difference in the mean of pre-test and post-test scores of the participants. Participants have a strong positivist science perspective. There was no statistically significant change in scientific epistemological beliefs of the participants after the Science Fair. On the other hand, it has been seen that the changes in the conclusions of the postmodern science, such as the interchangeability of scientific knowledge and the subjectivity of science.

Keywords: *scientific epistemological belief, adult learning, informal learning environment, science fair*

INTRODUCTION

Epistemology is a philosophy that deals with the knowledge and nature of knowledge. The concept of belief is the psychological understanding of individuals with their emotional and cognitive dimensions, shaped by their past experiences (Karakuş & Aydaoğdu, 2014). People develop epistemological beliefs. This process begins with an objectivist, dualistic view of certain and stable knowledge. Kienhues, Bromme, & Stahl (2008) described that people's cognition about the nature of knowledge and knowing are epistemological beliefs. Epistemological beliefs affect comprehension and learning of people. Scientific epistemological beliefs reveal the philosophical understanding of the science subjects about the meaning, producing and sharing processes of scientific knowledge (Deryakulu & Bıkmaz, 2003). Hofer and Pintrich (1997) categorized epistemological beliefs based on four contiguous, empirically supported dimensions (shown in Figure 1)

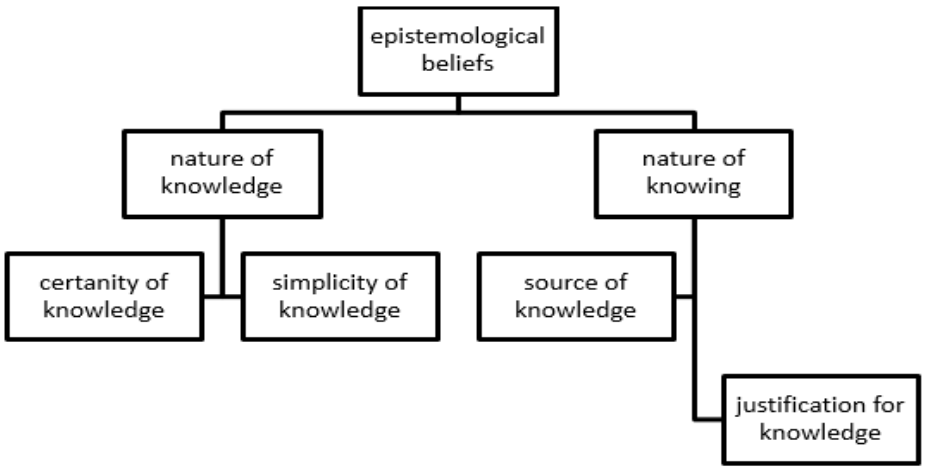

Figure 1. Model of epistemological beliefs by Hofer and Pintrich (1997)

Certainty of knowledge is the first dimension, representing the degree to which knowledge is seen as fixed and absolute true or temporary, growing, changing and constantly evolving. This dimension evaluates peoples' beliefs in the right answer in scientific knowledge. For instance, all questions in science have one right answer. The second dimension is the *simplicity of knowledge* representing either is stored in mind as single data or as embedded in larger theoretical and methodological contexts. This dimension also evaluates assessing students' beliefs about scientific knowledge. These two dimensions are called the *nature of knowledge* of epistemological beliefs. The *justification for knowing* is the third dimension representing knowledge can either be justified scientifically or non-scientifically. This dimension examines learners' views on the role of experiments in science and how learner justifies scientific knowledge. Scientists have more than one way to test their ideas in science. The fourth dimension is *source of knowledge* representing the knowledge can be acquired from external source like an expert people or from internal sources like studies and scientific experts. This dimension assesses students' beliefs about scientific knowledge residing in external authorities. Everybody has to believe what scientists say. These two dimensions are called the *nature of knowing* (Wu & Tsai, 2011).

Understanding Science

Although there are many approaches in scientific epistemological beliefs, traditional (positivist) and non-traditional (post-modern, constructive) approaches have been focused and studied in literature (Yavuz, Büyükekşi, & Büyükekşi, 2014). In the positivist view developed in the mid-19th century, knowledge is scientific knowledge and comes from positive affirmation of theories through scientific method. According to this view, the world consists of regularities which are detected by scientists, inferring knowledge about the real world by observing it. Positivism does not prove that there are no

abstract ideas, laws and principles, beyond observable facts and relationships and necessary principles. Positivism needs solid proof (Uddin & Hamiduzzaman, 2009).

Post-modern understanding science is opposed to the Positivism. In Post-modern perspective scientific knowledge is constructed by scientists, and therefore not discovered from the world through strict scientific method. The main difference between these two approaches is as seen in Table 1.

Table 1
Comparison of traditional and non-traditional scientific understandings

Positivist	Post-Modern (Constructivist)
Tries to reveal objective facts	Subjective; Science is influenced by people's culture, intuition, imagination
Scientific knowledge is permanent, and unchangeable	Scientific knowledge is falsifiable, and changeable
Repeatable, based on observations and experiments	Scientist's point of view affects his/her observation

Science Fair

Learning is a lifelong process. This process can take place in a formal educational institution such as a school with certain programs and plans, and it can also occur in informal environments such as museums, zoos, botanical gardens, playgrounds, aqua parks, media, hospitals, cinemas, zoos, etc. In particular, teachers can easily follow whether or not students use scientific processes and try to find solutions to problems by using these processes and students interactively interpret nature and natural phenomena in that process. Science fairs are exhibitions that are open to the public in a festival, where students are invited to visit their own projects. Students develop their research skills, critical thinking skills and positive attitudes toward science during the science fair (Tortop, 2013a). Thus, science fair provides an opportunity for students to showcase their own science research and design projects. By having to present their science projects, students are encouraged to solve their research questions deriving by their own curiosity about the world around them. When visitors come to see these projects in science fair, everyone can acquire some scientific knowledge from science project owners (Şahin & Çelikkanlı, 2014; Türkmen, 2010, 2015). Science fairs can be considered an effective informal science teaching environment. In Turkey, most of the Science fairs are carried out by TÜBİTAK (The Scientific and Technological Research Council of Turkey) in formal education, because the responsibility of promoting, developing, organizing, and coordinating research and development in education is in TÜBİTAK.

In literature, many researches have been done about the educational epistemological beliefs of individuals and their predictors, and level of learning of children and adults in informal learning environments (Kaleci & Bıkmaz, 2012). In many of these studies, the relationship between epistemological beliefs and teaching outputs was examined (Briseno, Adriana, & Anderson, 2007; Borun, Chambers, & Cleghorn, 1996; Dierking & Falk, 1994; Falk, Moussouri, & Coulson, 1998; Anderson, Piscitelli, Weier, Everett, & Tayler, 2002; Patterson, 2007.). In researches that especially science fairs are the subject, the sample were selected by students (Czerniak & Lumpe, 1996; Grinnell, Dalley, Shepherd, & Reisch, 2018; Sontay, Anar, & Karamustafaoğlu, 2019; Syer & Shore, 2010; Şahin, 2012; Şahin & Çelikkanlı, 2014; Tortop, 2013a; Wilson, Cordry, & Uline, 2004), pre-service teachers (Bunderson & Anderson, 1996; Tortop, 2014; Yavuz et al., 2014), and in-service teachers and school principals (Tortop, 2013a; Tortop, 2013b).

Purpose of Study

This study is unique in that way that the science fairs were used in terms of the informal learning environment where epistemological beliefs are questioned, and that the adults were selected as the study group.

The aim of the study was to determine whether science fairs affect adults' scientific perceptions and scientific epistemological beliefs they had. Two sub problems have been identified for this purpose:
1. Is there a statistically differences between the pre-test and post-test scores of the scientific epistemological beliefs of the participants?
2. What are the participants' thoughts on science perceptions and science fairs?

METHOD

In this study, mixed method was used by collecting quantitative and qualitative data. For quantitative data, a single group pre-test post-test design was applied from pre-experimental models. To increase the validity of the data and to provide data diversity, interview method was applied for qualitative data.

Study Group

The study group is made up of adults who visited 12 science fairs with TÜBİTAK approval. These science fairs were organized by 12 secondary schools on different days in areas where the socio-economic levels are good and above the province of Bornova in İzmir. Individuals who participated in the study were included in the study on the basis of volunteerism after informing about the research at the entrance of the science fair area. 185 adults participated in the study and completed the Scientific Epistemological Beliefs Scale as a pre-test in the process of the research, but after 2 weeks, only 92 adults (69 female, 23 male) accepted to fill in post-test questions. Therefore, the sampling group consisted of 92 individuals selected from the people visited to science fair by random sampling method. These adults are the first-degree relatives, such as parents, grandparents, grandparents, and grandparents, of students who are representors of their projects in science fair. Moreover, 2 people from each science fair was selected randomly from 92 participants for interview. After selecting 24 adults, 4 adults changed their mind in regards to the interview.

Instruments

Two different data collection tools were used in the study. The first was "Scientific Epistemological Beliefs Scale" developed by Pomeroy (1993) and adapted to Turkish by Deryakulu and Bıkmaz (2003). The scale consists of 30 items and 5 Likert type. 22 of these items reflect the traditional perspective of science and is positive sentence structure; the other 8 items (3.5.13.14.18.20.21.22. items) reflect non-traditional (post-modern) perspective of science and is negative sentence structure. Reliability coefficient of the scale (Cronbach Alpha) was 0.91.

The second tool was the interview questions. The researcher has prepared and developed 4 open ended questions with opinions from 3 different expert in order to examine the opinions of the parents about science, scientific knowledge, scientists, science fair and informal learning environment.

Data Collection

The study was carried out at 12 science fairs which was held in 12 different schools in İzmir. These fairs took an average of 6-7 hours within 1 day. At least 20 different projects in the two categories which are scientific research and scientific design, was prepared by in the light of science, mathematics, Turkish literature, foreign language and, religious culture and moral education curriculum in the science fair program (Table 2).

Table 2
Demographic information about projects in science fair

	Science	Math	Turkish Lit.	Foreign Lang.	Religious Culture & Moral Education	Total
Scientific Research	76 (%59.4)	37 (%28.9)	-	-	15 (%11.7)	128
Scientific Design	36 (%30)	20 (%16.7)	12 (%10)	25 (%20.8)	27 (%22.5)	120
Total	112 (%45.2)	57 (%22.9)	12 (%4.8)	25 (%10.1)	42 (%17)	248

Selected adults were voluntarily required to fill in the "Scientific Epistemological Beliefs Scale" for pre-testing purposes in the entrance of Science Fair. At least 15 days after the end of the science fair, the same "Scientific Epistemological Beliefs Scale" was applied as a post-test. 20 participants (8 males, 12 females) were interviewed considering the mean score differences between pre-test and post-test data.

Analyzing of Data

In the study, data were gathered on the basis of a 5-point Likert type 30-item scale and interview questions. Participants' pre-test and post-test scores of the Scientific Epistemological Beliefs Scale were compared via using the SPSS 17 package program. To determine whether there was a significant difference between the arithmetic mean scores of pre-test and post-test at 0.05 level, data showing normal distribution were analyzed by independent samples t-test of parametric tests. It was accepted that if the average mean score is below 2.60, it reflects the concept of "post-modern science", if the average mean score is between 3.41 and 5.00, it reflects a strong conviction in the understanding of "positivist science" (Terzi, 2005).

The qualitative data obtained by interview was analyzed with frequency analysis and the descriptive data were obtained. According to this descriptive approach, the data obtained according to the previously determined "themes" are summarized and interpreted (Yıldırım & Şimşek, 2013).

FINDINGS

Epistemological beliefs influence people learning and comprehension of scientific information. Scientific epistemological beliefs are shaped during childhood and school life, for that reason adults are known to be resistant to change (Karakuş & Aydaoğdu, 2014). The effects of interventions to change epistemological beliefs are slow (Baxter-Magolda, 1988; Karakuş & Aydoğdu, 2014) and tough process (Davis, 1997; Karakuş & Aydaoğdu, 2014). Although theposttest scores are 0.333 higher than pretest scores, there was no statistically significant difference in the average of the pre-test and post-test scores of the participants. According to results, participants understood "positivist science", after the science fair this opinion has not changed but on the contrary understanding of "positivist science" has been strengthened (Table 3).

Table 3
Independent samples t-test scores

	m	Ss	df	t	p
Pre-test	3.122	.254	92	.484	.301
Post-test	3.455	.313			

On the other hand, when each item of the epistemological belief scale is examined separately, the statistically significant difference in the level of 0.05 was found in 9 items. Three (5^{th}, 18^{th} and 20^{th} items) of these are related to the post-modern understanding of science and are inverse coded. The 5th item is related to importance of intriguing in scientific research whilst the 14^{th} item is related to disprove of the theories that exist in the scientific invention process and the 20^{th} item is related that

process of the generation of ideas from scientific and non-scientific sources is unusual for scientists (Table 4). The reason why there are meaningful differences in these items is probably that students present their projects. In the presentation time they mentioned how they start, and gather data and analyze their data before making a conclusion. This process of scientific research is called nature of science having some characteristics of post-modern science perspective.

In other 9th, 16th, 23rd, 28th, 29th and 30th items related to positivist science understanding. It is mentioned that the work of scientists can be defined as the art of what they do in the 9th item and participants' scores averages rose from 3.31 to 3.96. The possible reason is that some projects' themes are intertwined in science and art, or result of different disciplines, mathematics, science, social science, music et. al. Qualitative data obtained from participants support this possible reason. For example,

V: "Our children and our lives are not far away to science and scientists. We learn by experimenting, by observation, by producing into our lives like scientists ..."

The16th item were concerned about people's perception of the difficulties of the process of scientific discovery and participants' scores averages rose from 3.17 to 3.69. 23th item is about science is based on repeated experiments and participants' scores averages decreased from 3.91 to 3.50. 28th item related to selection of science as a professional career. The possible reason is the lack of course diversity in our schools. If elective courses related to science are increased, there is an increase in the view that professional preferences in this area will increase. The participants' scores averages increased from 4.33 to 4.70. Item 29 is about their teaching method to teach science knowledge to students. The problem of teachers' teaching methods increased from 3.95 to 4.38. There is an increase in the number of students reading scientific publications in item 30. The participants' scores averages increased from 4.04 to 4.38 (Table 4).

Table 4
The result of epistemological belief scale items

Questions	Pre-test	Post-test
*5. Intuition plays an important role in scientific discovery.	2,28	1,54
9. Actual work of scientists can be described as art.	3,31	3,96
16. The course of scientific discovery resembles the process of reaching a difficult judicial decision.	3,17	3,69
*18. The process of scientific discovery often involves purposeful discard of accepted theory.	2,76	1,75
*20. It is not unusual for scientist to get ideas from variety of seemingly unrelated scientific and non-scientific sources.	2,21	1,75
23. Science is based on experiments which any other competent scientist in the field should be able to repeat at will.	3,91	3,50
28. If students are considering career in science, they should be encouraged to take as much as possible for their electives in high school.	4,33	4,70
29. The way science is taught is a bigger problem in the Turkey than the teachers' level of competence in science concept.	3,95	4,38
30. The biggest key to increasing scientific literacy is increasing students' ability to read science texts and articles.	4,04	4,38

* Inverse coded items that reflect the notion of post-modern science

The first interview question is about participants' thoughts on science perceptions and science fiction. Responses from participants can be grouped under 5 codes in terms of children; the importance of science (place in our lives) (15 adults), Social skills of children (12 adults), the one of the characteristics basic of constructivist approach and informal learning environments is Learning by doing and Learning in everywhere (7 adults), and Scientific process (5 adults). When this question was asked to the same participants for themselves, 13 adults answered with "No or I do not know" but 7 adults answered with

science fairs are important for adults. According to them one of the science fairs goals for adults was that science is useful for their lives (7 adults), science affect people to develop their social skills (5 adults), science gives an opportunity to people to inference about education and training (4 adults) (Table 5).

Table 5
Frequency of first Interview question

1. question	Answers	Frequency
a) What was the purpose of this Science Fair for children about science?	• The importance of science (place in our lives)	15
	• Social skills	12
	• Learning by doing	7
	• Learning in everywhere	7
	• Scientific process	5
b) Do they also have goals for adults? What do you think?	Yes	7
	• The importance of science (place in our lives)	7
	• Social skills	5
	• Inference about education and training	4
	I do not know / No	13

Nineteen participants said "yes" in the second interview question, "Does Science Fair makes your perceptions change about science, scientific knowledge, and scientists". The reason of one person said "no" is that "I do not have any prejudice about the scientists and science, therefore my perception has not changed". The other participants' thoughts were categorized into 3 codes which are science, scientific information, and scientist. The term of science, relating imagination, inquiry, and activities that we learn about scientific information were described by participants. Moreover, participants said that scientific information is changeable, sum of experience which is based on experiments and observation. According to the participants, scientist is patient, different from other people, researcher, always not accept impossibility and unyielding in the hard situations and works for human beings. All of the explanations are close to the understanding of post-modern science (Table 6).

Table 6
Frequency of second interview question

2. question	Answers	Frequency
Does Science Fair make your perceptions change about science, scientific knowledge, scientists, etc.? If yes, could you explain?	***Yes***	19
	Science;	
	• Depends on imagination	16
	• Required inquiry	14
	• Learning activities	11
	Scientific information;	
	• Changeable	10
	• Sum of experiences	15
	• Based on experimentation and observation	16
	Scientist;	
	• Patient	
	• Different	15
	• Researcher	11
	• Unyielding	17
	• Works for human being	1
	• Not accept impossibility	9
		13
	No	1

When analysing the interview question 3.a., 11 participants said that they learned new information from science fair and 9 participants said they did not learn or remember. The most learned knowledge is related Science (7 adults) and Religious Culture & Moral Education.

In the 3.b. interview question, new learned knowledge from science fair caused participants to change their way of thinking and to gain different points of view (9 adults), to realize that they are still learning in that age (6 adults), to learn how and by whom the technology was made (4 adults), notice old information and judgments changeable (3 adults) (as seen in Table 7).

Table 7
Frequency of third interview question

3. question	Answers	Frequency
a) Is there any information you have learned here for the first time in this science fair? What is/are this/these?	Yes	11
	• Science	7
	• Religious Culture & Moral Education	6
	• Math	3
	• Turkish Language	2
	• Foreign language	1
	No/I do not remember	9
b) If you acquire this new knowledge, does it cause you any change? How?	• Gain different points of view	9
	• Realized still learning (lifelong learning)	6
	• Learned how and by whom the technology was made	4
	• Old information and judgments changeable	3

The last question of the interview is related to the difference between learning in classroom and science fair. All participants gave at least four reasons in order to explain the difference between learning in classroom and science fair. According to them;

> V: Learning environment is open area and students are free wherever wanted to see …
> VII: Most probably you saw all students were very excited and curious. They watched and listened very carefully the representors…
> X: … most of students having great time. I believe if the kid is happy, you can teach them whatever you want as a teacher.
> XI: The science fair has a significant influence on students' motivation, as I observed every student walk around all project stand. Motivation leads to increase students' engagement that leads to learning.

Their responses are in parallel with Türkmen (2010) study declaring the characteristics of ideal teaching in informal learning environment (Table 8).

Table 8
Frequency of forth interview question

4. question	Answers	Frequency
Is there any difference to learn scientific information between in the classroom and science fair? If yes Could you explain what difference is?	• Funny	20
	• Better acquisition of knowledge	17
	• More exciting	13
	• Comfortable and more free	11
	• More motivated and engaged	10
	• Hands-on (not rote learning)	8

DISCUSSION

In this study, the impact of science fairs, which is one of the informal learning environments, on the scientific epistemological beliefs and scientific perceptions of adults and additionally adults' thoughts about science fair in the light of learning environment has been examined. There are few studies in literature that both scientific epistemological beliefs and scientific fairs as the research subject, that makes this study unique. Most of adults have been educated with traditional teaching methods. Therefore, it is important to reveal adults' scientific epistemological beliefs to prevent misconceptions about scientific information that may arise between adults and children and to promote change these scientific epistemological beliefs in the direction of the post-modern approach to increase scientific literate individuals. Just like Dewey's famous phrase "Education is *not preparation* for *life*, education is *life* itself", achieving information in school should not be different and should be used in social life. We have not to forget that the information we learn comes from nature and social life. Children learn in school life as well as in social life. Thus, Dewey emphasizes education is a lifelong process and occurs in everywhere. Generally, children learn from their parents and relatives, friends, even foreign people in society. Science fair is one of good examples of informal learning environment and very convenient for this purpose.

This study showed that there is not a statistically significant change in the scientific epistemological beliefs that adults have. This is an expected result because literature says it is difficult and time-consuming to change epistemological beliefs (Baxter-Magolda, 1988; Davis, 1997; Hofer & Pintrich, 1997; Kaleci & Bıkmaz, 2012; Karakuş & Aydaoğdu, 2014; Kienhues et al., 2008; Terzi, 2005; Yavuz et al., 2014). On the contrary, there is a statistically significant difference in the 9 items of scientific epistemological beliefs scale; this is the positive aspect of study. Moreover, the pre-test and post-test mean scores are high when the socio-economic and educational status of the participating adults is considered. The studies of Briseno et al. (2007), Dierking & Falk (1994), and Türkmen (2015) that was carried out with adults showed that adults in high socio-economic and educational status have positive effect to reach to purpose of studies.

There was no significant statistical difference in 5 out of the 8 questions regarding postmodern science understanding, but only 3 of them showed significant difference in pre-test scores. This result indicates that the subjects do not have postmodern science understanding. For example, there are no places for intuition, discarding scientific theory and evidence from non-scientific source in science. The fact that only 6 of the 22 questions about positivist understanding of science have a significant difference in the post-test scores is a sign of the students to have more positive attitudes of positivist science understanding. Their thoughts are generally science should be related evidence from the observations and experiments of the scientist. Every evidence should be obtained with 5 senses; otherwise it is not acceptable and suitable for positivist science perspectives

CONCLUSION

The science fairs have positive effect in increasing peoples' understanding of scientific perception, especially scientific process and scientist behaviours, and social skills in the life of both adults and students. Moreover, these science fairs affect people learnings. Most of the adults have learned new scientific knowledge in the field of Science and Religious Culture & Moral Education. When comparing formal learning and informal learning environment, most of the adults agree that learning in an informal environment is funny, more exciting and comfortable, and freer. Adults as learners are more motivated and engaged in these science fairs.

REFERENCES

Anderson, D., Piscitelli, B., Weier, K., Everett, M., & Tayler, C. (2002). Children's museum experiences: Identifying powerful mediators of learning. *Children's Museum Experiences, 45*(3), 213-231.

Baxter-Magolda, M. B. (1988). The impact of the freshman year on epistemological development: Gender differences. *Paper presented at the Annual Meeting of the American Educational Research Association*, New Orleans: LA.

Borun, M., Chambers, M., & Cleghorn, A. (1996). Families are learning in science museum. *Curator, 39*(2), 123-138.

Briseno, A. G., Adriana, D., & Anderson, A. (2007). Entry and emergent agendas of adults visiting an aquarium in family groups. *Visitor Studies Association, 10*(1), 73-89.

Bunderson, E. D., & Anderson, T. (1996). Preservice elementary teachers' attitudes toward their past experiences with science fairs. *School science & mathematics*, *96*(7), 371-378.

Czerniak, C. M., & Lumpe, A. T. (1996). Predictors of science fair participation using the theory of planned behavior. *School Science and Mathematics*, *96*(7), 355-361.

Davis, E. A. (1997). Students' epistemological beliefs about science and learning. *Paper presented at the Annual Meeting of the American Educational Research Association,* Chicago IL.

Deryakulu, D., & Bıkmaz, F. H. (2003). The validity and reliability study of the scientific epistemological beliefs survey. *Educational Science and Practice, 2*(4), 243-257.

Dierking, L. D., & Falk, J. H. (1994). Family behavior and learning in informal science settings: A review of the research. *Science Education*, *78*(1), 57-72.

Falk, J., Moussouri, T., & Coulson, D. (1998). The effect of visitors' agendas as museum learning. *Curator*, *41*(2), 107-120.

Grinnell, F., Dalley, S., Shepherd, K., & Reisch, J. (2018). High school science fair: Student opinions regarding whether participation should be required or optional and why. *Plos One*, *13*(8), 1-16. Retrieved from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0202320

Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, *67*(1), 88-140.

Kaleci, F., & Bıkmaz, E. (2012). Epistemolojik İnançlar Üzerine Bir Derleme (The Review of Epistomological Beliefs). *X. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi (X. National Science and Mathematics Education Congress), Niğde,* 129.

Karakuş, F., & Aydaoğdu, B. (2014). A comparative study on the change of pre-service teachers' scientific epistemological beliefs. *Dicle University Journal of Ziya Gökalp Faculty of Education*, *23*, 373-394.

Kienhues, D., Bromme, R., & Stahl, E. (2008). Changing epistemological beliefs: the unexpected impact of a short-term intervention. *British Journal of Educational Psychology, 78*(4), 545-565.

Patterson, A. R. (2007). "Dad look, she's sleeping": parent–child conversations about human remains. *Visitor Studies*, *10*(1), 55-72.

Pomeroy, D. (1993). Implications of teachers' beliefs about the nature science: comparison of the beliefs of scientists, secondary science teachers, and elementary teachers. *Science Education*, *77*(3), 261-278.

Sontay, G., Anar, F., & Karamustafaoğlu, O. (2019). Opinions of secondary school students attending 4006-TUBİTAK Science Fair about science fair. *International e-Journal of Educational Studies*, *3*(5), 16-28.

Syer, C. A., & Shore, B. M. (2010). Science fairs: What are the sources of help for students and how prevalent is cheating? *School Science and Mathematics*, *101*(4), 206-220.

Şahin, E., & Çelikkanlı, N. Ö. (2014). The impacts of a secondary school science exhibition on the students in charge. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *8*(2), 71-97.

Şahin, Ş. (2012). The effect of science fairs on the 10th grade students' attitude towards chemistry. *Uşak University Journal of Social Sciences, 5*(1), 89-103.

Terzi, A. R. (2005). A research on scientific epistemological beliefs of university students. *The Journal of Social Sciences, 7*(2), 298-311.

Tortop, H. S. (2013a). Development of teachers' attitude scale towards science fair. *Educational Research and Reviews, 8*(2), 58-62.

Tortop, H. S. (2013b). Science teachers' views about the science fair at primary education level. *Turkish Online Journal of Qualitative Inquiry*, *4*(2), 56-64.

Tortop, H. S. (2014). Examining of the predictors of pre-service teachers' perceptions of the quality of the science fair projects in Turkey. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *8*(1), 31-44.

Türkmen, H. (2010). İnformal (Sınıf-dışı) Fen Bilgisi Eğitimine Tarihsel Bakış ve Eğitimimize Entegrasyonu (Historical Overview of Informal (Out-Door) Science Education and Its Integration to Our Education). *Çukurova University Faculty of Education Journal, 3*(39), 46-59.

Türkmen, H. (2015). Visiting agenda of adults for informal learning environment: The case of Sasalı Wildlife Park. *Journal of European Education*, *5*(1), 15-22.

Uddin, M. N., & Hamiduzzaman, M. (2009). The philosophy of science in social research**.** *The Journal of International Social Research, 2*(6), 654-664.

Wilson, J. D., Cordry, S., & Uline, C. (2004). Science fairs: Promoting positive attitudes towards science from student participation. *College Student Journal 38*(1), 112.

Wu, Y. T., & Tsai, C. C. (2011). High school students' informal reasoning regarding a socio-scientific issue with relation to scientific epistemological beliefs and cognitive structures. *International Journal of Science Education*, *33*(3), 371-400.

Yavuz, S., Büyükekşi, C., & Büyükekşi, S. I. (2014). Effect of science fair on epistemological beliefs. *Karaelmas Journal of Educational Sciences, 2,* 168-174.

Yıldırım, A. & Şimşek, H. (2013). Sosyal Bilimlerde Nitel Araştırma Yöntemleri (Qualitative Research in Social Science). 9th Ed. Ankara. Seçkin Publishing.