

Science Teacher Candidates' Attitudes and Opinions Concerning Nuclear Power Plants: a Nuclear Research Reactor Trip

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ABSTRACT

When the fact that information changes and increases very quickly today is taken into account, individuals' ability to adapt to this change shows parallelism with the education they will receive. This study aims to determine the effect of a planned technical trip made to the Nuclear Research Reactor located in Istanbul Technical University Energy Institute campus on science teacher candidates' attitudes and opinions. The research, quantitative data of which were collected by the "Nuclear Power Plants Attitude Scale" developed by Özdemir and Çobanoğlu (2008) and qualitative data of which were collected by a semi-structured interview form developed by the researchers, was designed as a mix-method research in which both methods are used together. In the study, a planned technical trip to a nuclear reactor was organized along with 17 teacher candidates studying in the 4th year (or senior year) of Science Teaching at Abant İzzet Baysal University. As a result of the research, a significant change was determined in teacher candidates' attitudes concerning nuclear power plants. In addition, 9 semi-structured interview questions were applied to the teacher candidates before and after the trip. As a result of the content analysis performed, 22 codes in total were identified under 4 theme titles, and a positive increase in terms of quality was determined in teacher candidates' opinions after the trip. Based on these findings, it can be said that candidate teachers' opinions on nuclear power plants to be established in our country changed for the establishment of nuclear power plants in our country by the effect of the technical trip made.

KEYWORDS

informal learning, socio-scientific topics, technical trip, nuclear power plants, attitude

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Introduction

Along with the rapid increase in world population, need for energy resources which is a reflection of the concept of energy on daily life keeps its place on the agenda of today's societies with the philosophy of sustainability. The concept of energy appearing as a common product of physics, chemistry, and biology fields (Gürdal, Bayram and Şahin, 1999) is interdisciplinary and is

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directly or indirectly associated with many concepts in sciences (Yürümezoğlu, Ayaz and Çökelez, 2009). The concept of energy among the basic concepts of science (Tobin et al., 2012; Jin and Anderson, 2012; Sağlam-Arslan, 2010; Boyes and Stanisstreet, 1991), along with its abstract nature (Rizaki and Kokkotas, 2013), is also evaluated as a kind of socio-scientific phenomena that concerns people and the environment today. Today, the use of nuclear energy having socio-scientific nature emerges as a universal topic which is mentioned and discussed at the most in this context.

Nuclear energy which is the most important topic with the maximum discussion areas today firstly got famous during World War II by the concepts such as "atomic energy", "nuclear reaction"; Einstein, Rutherford, Hans, Strassman and Oppenheimer were among the first scientists working in the field as from the beginning of the 20th century (Karabulut, 1999). In our country, attempts to establish a nuclear power plant for electricity generation at the end of the 1960s came to stop by the failure experienced concerning the establishment of a power plant of 300 MW in Mersin Akkuyu between the years 1967-1974. In 1983, the second attempt in Mersin Akkuyu failed and lost its popularity in the country's agenda after 1986 Chernobyl accident. Nuclear studies which were interrupted by the statement of Bülent Ecevit, the Prime Minister of that period, of "nuclear energy plan has been cancelled as it is much more expensive than it is planned" when the 3rd experimental works were initiated in 1998, began to be studied by the enactment of laws for the fourth time in line with the ongoing discussions about the topic between the parliament and palace in 2007. Along with the enactment of the law, two of the three nuclear power plants to be established in Mersin and Sinop are expected to be activated between 2010-2020 (Ediger and Kentmen, 2010).

Nuclear energy and its use, especially its effects on the environment have been the subject of many studies. In social science studies, the effect of nuclear energy use on the environment, damages to human health and the environment caused by nuclear accidents and the positive and negative results that will occur in the future with the use of this energy were frequently discussed, and the society's attitudes and risk perception of this energy were emphasized (Hinman et al., 1993, cited by Özdemir and Çobanoğlu, 2008). Although behavior psychology related to people's attitudes before and after the accidents in Chernobyl, Three Mile Island, and Fukushima were greatly included in the studies, only 1 of them is a study related to science education perspective (Brown et al., 1987). In their study, Brown et al. (1987) examined the students' drawings related to nuclear power plants before and after the Chernobyl accident and concluded that drawings of the students after the accident were more realistic compared to the drawings before the accident.

When the fact that information changes and increases very quickly today is taken into account, individuals' ability to adapt to this change shows parallelism with the education they will receive. With the support of formal education and informal education they receive under the roof of educational institutions, lifelong learning philosophy will have been implemented. (Bozdoğan and Yalçın, 2006). Many studies carried out show that informal education used along with the formal education offer students authentic experiences, provide an opportunity to interact with real objects and keep feelings of curiosity and interest alive (Pedretti, 2004). Accordingly, studies indicating that informal

education positively affects the students' motivation, success and interests are found in the literature (Bozdoğan and Yalçın, 2006; Ramey-Gassert, 1997; Braund and Reiss, 2006; Ertaş et al., 2011). In addition, "out-of-school teaching" means education in which areas and institutions outside the school building are used during school period depending on the curriculum. The out-of-school training uses informal education resources for formal education (Salmi, 1993). In this sense, science centers, museums, aquariums, out-of-school scientific activities conducted in planetariums, field trips, technical trips and science camps are the informal environments used in the realization of out-of-school science education. Studies related to informal science environments have been frequently seen in recent years (Ertaş et al., 2011; Bozdoğan and Yalçın, 2006; Pedretti, 2004; Bozdoğan, 2007; Karagöz, 2007; Kolsto, 2000; Tortop, 2007)

However, some researchers state that problems such as the fact that teacher or guide fails to achieve educational outcomes they desire concerning out-of-school education may arise. Rennie and McClafferty (1996) have indicated that the entertainment dimension can prevent the educational dimension in science centers where students have a good time. In this respect, it can be said that further research in which out-of-school activities and out-of-school learning process are investigated is needed.

Investigation of socioscientific topics in different learning environments by various methods is considered to be important. Therefore, in this study, it was aimed to determine the teacher candidates' attitudes and opinions concerning the nuclear power plants through the informal education of energy needs, nuclear energy, and power plants which frequently remain on the agenda.

Significance of the Research

News related to the establishment of nuclear power plants, what the returns to the country and the environment would be, plant's establishment conditions and the measures need to be taken that particularly remain on the agenda of Turkey are frequently encountered in the media. Basic information resources such as environment, formal environments, and media are effective in the decision-making processes of individuals (Korpan et al., 1997) Additionally, in a case concerning the establishment of nuclear power plants, different information resources including field experts, environmental organizations, media and politicians will affect the decision-making processes by producing correct or incorrect information in line with their own vision and mission, interest, world-view or policies (İşeri, 2012). It is important that our teachers structure their knowledge concerning the nuclear power plants that interest today's human being and future generations and that include positive and negative situations at different levels within themselves.

Field trips, which are among the innovative learning models and are one of the methods applied in informal environments, have an important place in student life in terms of providing a variety of activities and first-hand experiences (Flexer and Borun, 1984). Furthermore, Yöneş (2008) has stated that the fact that the trips performed by informal education are more effective will provide students with achievements in many ways compared to traditional teaching methods.

Another important point is that more detailed and healthy investigation of teacher candidates' attitudes and opinions was made possible as a result of

gaining first-hand experience by taking them to a real reactor during a technical trip. The fact that teachers who are both role model and a guide for elementary and secondary school students present concrete experiences in different ways in this way will provide insight for them to configure information.

Therefore, it was aimed to determine the effect of the trip made on teacher candidates' attitudes and opinions concerning the nuclear power plants. In the literature, no research which was carried out with teacher candidates concerning the science education perspective and nuclear power plants, and which was related to the effect of informal education on this subject in Turkey was encountered. This research is expected to make significant contributions to the field in these aspects.

Method

Research Model

In the research, it was aimed to determine the effect of a planned technical trip made concerning the subject of "Nuclear Power Plant" on science teacher candidates' attitudes and opinions. At this point, an enriched (triangulation) design in which data are collected and more valid results are obtained from this aspect is preferred by using mixed methods research in which qualitative and quantitative methods are used together (Fraenkel and Wallen, 1996).

Just claiming that this study was a mixed method research does not make it one. Authors should show how and why this study counts as one.

The nature of the field trip should be described. What kinds of experiences were the participants had. How and why any changes in their attitudes and opinions were expected as a results of those experiences? Should be explained and discuss in detail.

Study Group

Study group of the research consisted of teacher candidates (N=17) studying in the 4th grade of the Department of Science Teaching at Abant İzzet Baysal University in the academic year 2013-2014. While determining participants, the design was made by one group pretest-posttest model without randomness (randomization) and matching, and the research was carried out on a single group on a voluntary basis.

As a location for a technical trip, "Triga Mark II" research reactor located in Istanbul Technical University Energy Institute campus was selected from among 3 nuclear research reactors existing in Turkey for experimental and training purposes. Operating since 1979, ITU TRIGA Mark II Education and Research Reactor is an open tank type reactor running with solid fuel elements occurring by homogeneously mixing of enriched uranium fuel with light water cooled and graphite reflector with zirconium-hydride moderator. 'Triga Mark II' nuclear research reactor, the aim of which is to raise the awareness of public about nuclear energy, was established under the leadership of Prof. Dr. Nejat Aybers. A research reactor was purchased from American General Atomics Company after many national and international approval processes. This reactor, the project design of which belonged to Americans and the construction process of which belonged to Turkish contractors, academicians, and engineers, has the feature of "an intrinsically safe reactor".

Data Collection Process

The path followed during the research can be summarized as follows:

- Permissions were received as a result of the necessary correspondence by contacting with Istanbul Technical University Energy Institute.
- The trip group was formed from the students who voluntarily wanted to participate in the trip, and brief information was given to teacher candidates about the location to visit before the trip.
- Before the trip, pre-interviews (semi-structured) were conducted by getting appointments from the determined teacher candidates, and the "Nuclear Power Plants Attitude Scale" was applied. This protocol was also repeated after the trip.
- During the practices carried out within the trip, teacher candidates were accompanied by 3 faculty members working in ITU Energy Institute and 4 researchers who conducted the research.

Quantitative Data Collection Tool

In the study, data were collected by the scale which was developed by Özdemir and Çobanoğlu (2008) that determines the teacher candidates' attitudes towards the nuclear power plants and the use of nuclear energy. The scale was of five-point Likert-type, and the grading scale which was indicated as strongly agree, agree, neutral, disagree and strongly disagree consisted of 25 items. A pre-application was performed again for the questionnaire, the validity and reliability studies of which were conducted by Özdemir and Çobanoğlu, with 178 teacher candidates due to its implementation in different sampling. Firstly, the exploratory factor analysis was performed to determine the structural validity of the main scale consisting of 25 items, 4 dimensions found by the researchers were reduced to 3 dimensions with the new application, and 5 items (4, 12, 13, 14 and 17) were removed from the scale. Among the items, 6,7, 8, 9, 10, 11, 19 and 20 were involved under *Negative Perceptions towards Nuclear power (Nuclear and Environment Relationship)* which is the 1st dimension, and Cronbach's alpha reliability coefficient was measured as .77. Items 1, 5, 18, 21, 22, 23, 24 and 25 were gathered under *Strategic Importance of Nuclear Power*, which is the 2nd dimension, and Cronbach's alpha reliability coefficient was calculated as .66. Items 16, 15, 2 and 3 were gathered under *Energy Policies in the World and Turkey*, which is the 3rd dimension, and Cronbach's alpha reliability coefficient of this dimension was measured as .62. The confirmatory factor analysis for the testing of the obtained model was performed by Lisrel 8.0 program, and this model was found to work well. The reliability coefficient for the entire scale was found to be .81. The final scale consisted of 20 items. While the minimum score that could be obtained from the scale which was prepared in 5-point Likert form consisting of 20 items was 20, the maximum score was 100.

Qualitative Data Collection Tool

In the study, a standardized open-ended interview method was used to determine how the planned technical trip affected the students' opinions on the issue of nuclear power plants. Open-ended questions provided the researcher with the opportunity of a flexible approach regarding the studied subject and the awareness of the important variables related to the subject (Yıldırım and

Şimşek, 2005). As a part of the qualitative research methodology, a semi-structured interview form consisting of 9 questions was prepared in accordance with the research objective. While developing interview questions, at the first stage, opinion related to the compliance of the measurement tool was received on the basis of its intended use by asking specialized experts for their opinions. At the second stage, tests were revised and prepared in accordance with the opinion of the expert (Özgüven, 1998). In this respect, whether a measuring tool could measure the case it intended to measure and the content-scope validity expressing the representativeness in a balanced way would have been tested (Şencan, 2005). The prepared semi-structured interview form was presented for the opinion of the 3 experts, and it was finalized by making the necessary corrections in accordance with the proposals received. Interviews conducted with the teacher candidates before and after the application were recorded by a tape recorder after receiving permission.

Results

Data Analysis

SPSS (PAWS Statistic 18) package program was used in the analysis of quantitative data of the research. In the study, the t-test was used while observing the significance between pre-test and post-test as well as the descriptive analysis, and Cronbach $\alpha = .05$ significance level was taken as a basis.

The content analysis was performed on qualitative data collected before and after the trip. The content analysis is a form of analysis which aims to define data and to reveal the truth that may be hidden in the data, and while doing this, interprets the similar data by bringing together them within the frame of certain concepts and themes (Yıldırım and Şimşek, 2011).

At this point, participants' identities were kept confidential, and codes and themes were obtained from teacher candidates' opinions. As a result of the content analysis, 22 codes in total were determined under 4 theme titles. To ensure the reliability of the study, the codes of two researchers independent of each other and the themes related to these codes were compared to confirm that the codes and themes in the study represented the conceptual categories in question. Besides, discussions were carried out through codes about which two researchers had different opinions, and the mentioned codes were united under the appropriate themes. For instance, two independent researchers came to an agreement about uniting teacher candidates' opinions specified as fault lines, earthquake zones, and earthquake zone under the code of fault line. As a result of the comparisons, the percentage of inter-codings reliability (cohesion) performed by researchers was calculated as .80 [(Reliability = consensus / consensus + difference of opinion) \times 100] (Miles and Huberman, 1994). Yıldırım and Şimşek (2011) stated that coding would be reliable if the percentage of coding cohesion was 70%. It was concluded that the coding was reliable because the reliability of the coding for the themes obtained was separately and generally greater than 70.

Findings and Interpretation

The paired sample t-test analysis was performed regarding the significant difference in participant science teacher candidates' attitude scores concerning

the nuclear power plants before and after the trip. The Nuclear Power Plants Attitude Scale pre-test and post-test Paired Simple t-test results are shown in Table 1.

Table 1. Nuclear Power Plants Attitude Scale pre-test and post-test Paired Simple t-test results

Measurement	<i>N</i>	\bar{X}	SS <i>p</i>	<i>Sd</i>	<i>t</i>
Pre-test	17	55.79	11.86	36	-4.33
Post-test	17	70.68	.000 15.39		

According to Table 1, it is seen that there is a statistically significant difference between the pre-test and post-test average scores of attitudes towards nuclear power plants [$t(36) = -4.33, p = .000$]. It is seen that while the Nuclear Power Plants Attitude Scale pre-test average score is $\bar{X} = 55.79$, the post-test average score is $\bar{X} = 70.68$. This finding shows that a planned technical trip organized has a significant effect on the attitude.

Opinions concerning the areas where nuclear power plants will be established in our country are shown in Table 2.

Table 2. Opinions concerning the areas where nuclear power plants will be established in our country

Opinion	Frequency	
	Before Trip	After Trip
Not expressing an opinion	8	1
Cannot be the right locations	3	3
Can be the right locations	6	14
Definitely are not the right locations	1	-

* The fact that total frequencies are more than the current number of participants can be explained by the fact that the opinions expressed are included in more than one code.

According to Table 2, the teacher candidates indicate that they have no opinion before the trip concerning the locations of nuclear power plants planned to be established in our country. Teacher candidates with opinions do not have clear opinions about why it could be the right location or why it could not be the right location. It was observed that the majority of teachers expressed their opinions after the trip. Also, it was seen that there was a significant increase in the number of those expressing an opinion about the fact that the locations of the plants to be established would be the right locations after the trip compared to the situation before the trip. This can be interpreted that the guidance of the faculty member working in ITU Energy Institute during the trip affected the planned technical trip made.

Opinions concerning the properties of the areas where nuclear power plants can be established in our country are shown in Table 3.

Table 3. Opinions concerning the properties of the areas where nuclear power plants can be established in our country

Opinion	Frequency	
	Before Trip	After Trip
Away from the city center	9	3
Away from the fault line	4	-
Locations with accessibility	3	-
Away from the water source	2	-
Far from terror	-	1

* The fact that total frequencies are more than the current number of participants can be explained by the fact that the opinions expressed are included in more than one code.

According to Table 3, the majority of teacher candidates express an opinion for the establishment of nuclear power plants away from the city center before the trip concerning the properties of the locations where nuclear power plants could be established in our country. The fact that people live in the city centers was stated as the reason in the interviews made. After the trip, almost all teacher candidates stated that nuclear power plants to be established in our country should be established in locations near water resources. This finding is interpreted that information about the fact that the reactor should be cooled and information about the fact that locations near water resources would be the reason for preference in this cooling given by the faculty member working in ITU Energy Institute in his presentation to teacher candidates could be effective in this great change in teacher candidates' opinions.

Opinions concerning the benefits of nuclear power plants are shown in Table 4.

Table 4. Opinions concerning the benefits of nuclear power plants

Opinion	Frequency	
	Before Trip	After Trip
Energy	17	14
National economy	1	3
Nuclear weapon production	-	4
Nonconsumption of natural gas	-	3
Nonconsumption of fossil fuel	-	3
Conservation of natural resources	-	2
Technological developments	1	-
Work area	-	1

* The fact that total frequencies are more than the current number of participants can be explained by the fact that the opinions expressed are included in more than one code.

When opinions concerning the benefits of nuclear power plants are examined in Table 4, opinions both before and after the trip were expressed as energy. However, an increase in the opinions concerning the country's development (national economy, nuclear weapon production, nonconsumption of natural gas, nonconsumption of fossil fuel, conservation of natural resources) can be interpreted as the effect of the trip. Also, the emergence of an opinion regarding the work area can be interpreted by the participants as the absence of

currently active nuclear power plant in Turkey and that a new business opportunity door would be opened with a nuclear power plant to be established. Opinions concerning the harm of nuclear power plants are shown in Table 5.

Table 5. Opinions concerning the harm of nuclear power plants

Opinion	Frequency	
	Before Trip	After Trip
Radiation exposure	13	1
Nuclear waste	3	4
Ecological balance	3	1
Place of establishment	10	-
Nuclear bomb	-	1
Explosion risk	-	12
No harm	-	6

* The fact that total frequencies are more than the current number of participants can be explained by the fact that the opinions expressed are included in more than one code.

When opinions concerning the harm of nuclear power plants are examined in Table 5, it is seen that then majority of the participants stated radiation to be the greatest harm in nuclear power plants before the trip, and it was observed that there was a decrease in this opinion and that opinions stating that nuclear power plants were not harmful emerged after the trip. It can be said that the fact that the faculty member in charge measured radiation in the environment when he was next to the reactor and stated that the amount of radiation measured was at the level that could be considered normal by giving examples from everyday life might be the reason for this. Also, it is seen that opinions on a nuclear bomb, explosion risk and the absence of their harm emerged after the trip.

Information resources concerning the nuclear power plants are shown in Table 6.

Table 6. Information resources concerning the nuclear power plants

Opinion	Frequency	
	Before Trip	After Trip
Those who do not remember	1	-
Undergraduate course	7	5
Social environment	3	1
Newspaper	7	2
TV	7	-
Scientific-technical magazines	7	2
Internet	10	4
Trip	-	17**

* The fact that total frequencies are more than the current number of participants can be explained by the fact that the opinions expressed are included in more than one code.

When the information resources related to nuclear power plants are examined in Table 6, it is concluded that the trip and the presentation made during the trip affected the teacher candidates' opinions on information resources. Also, it is seen that the media (newspapers, the Internet, TV) were effective in the formation of opinions on nuclear power plants. Therefore, it can be said that the importance of the media's objectivity should be presented considering the fact that it affects the people's opinions concerning the socio-

scientific issues such as nuclear power plants. As it is seen in the table above, it can be interpreted that teacher candidates' confidence in the media (newspapers, TV, the Internet) and the undergraduate courses might be reduced, and also all teacher candidates who participated in the trip (**17) stated the trip to be a more reliable information source.

Opinions concerning the effect of nuclear power plants on the environment are shown in Table 7.

Table 7. Opinions concerning the effect of nuclear power plants on the environment

Opinion	Frequency	
	Before Trip	After Trip
Those without opinion	2	-
Radiation exposure	7	2
Nuclear waste	3	-
Nuclear waste	1	1
Human health (cancer)	4	2
Air and water pollution	2	2
Loss of fertile soil	1	9

* The fact that total frequencies are more than the current number of participants can be explained by the fact that the opinions expressed are included in more than one code.

When opinions concerning the effect of nuclear power plants on the environment are examined in Table 7, the opinion indicating that they have no harm showing parallelism with the finding appeared in the table of the opinions concerning the harm of nuclear power plants increased substantially after the trip. Also, it was seen that the frequency of those who expressed the opinion that radiation might have effects on the environment before the trip decreased after the trip.

Opinions concerning the nuclear wastes are shown in Table 8.

Table 8. Opinions concerning the nuclear wastes

Opinion	Frequency	
	Before Trip	After Trip
There is no waste	1	-
Harmless	1	2
Harmful	5	3
Those without opinion	11	1
Valuable	-	4
Storage	-	10

* The fact that total frequencies are more than the current number of participants can be explained by the fact that the opinions expressed are included in more than one code.

In Table 8, when the table of the opinions concerning the nuclear wastes is examined, although misinformation about the fact that nuclear power plants do not have waste was expressed by a teacher candidate before the trip, all of the participants expressed opinions concerning the waste generated after the trip. After the trip, it was seen that the majority of teacher candidates expressed the opinion that wastes of nuclear power plants must be stored properly. Additionally, it was seen that although the number of teacher candidates

without opinions on nuclear wastes was quite high before the trip, an opinion concerning the fact that nuclear wastes are harmless and even the wastes generated are valuable emerged after the trip. The presentation made by the faculty member in charge during the technical trip was considered to be effective in this.

Teacher candidates' opinions concerning the establishment of nuclear power plants in our country before and after the trip are shown in Table 9.

Table 9. Opinions concerning the establishment of nuclear power plants in our country

Opinion		Frequency
Before Trip	After Trip	
Yes	Yes	2
No	Indecisive	1
No	Yes	7
No	No	2
Yes	Indecisive	2
Indecisive	Yes	3

In Table 9, it is seen that seven teacher candidates had negative opinions concerning the nuclear power plants to be established in our country before the trip, and the same teacher candidates' opinions were positive after the trip. Also, it is seen that a teacher candidate expressed a negative opinion before the trip and then expressed an indecisive opinion, and that three teacher candidates expressed an indecisive opinion before the trip and then expressed a positive opinion after the trip. Besides this, it was seen that opinions of two teacher candidates expressing a positive opinion before the trip did not change after the trip. Also, it is seen that opinions of two teacher candidates expressing negative opinions before the trip did not change after the trip. And it is also seen that although two teacher candidates expressed positive opinions before the trip, they expressed indecisive opinions after the trip. In consideration of all of these, it was revealed that candidate teachers' opinion changed for the establishment of nuclear power plants in our country by the effect of the technical trip made.

Discussion and Conclusion

It is seen that the attitudes of science teacher candidates whose attitudes towards nuclear power plants were examined increased as a result of informal education. Furthermore, Ökesli (2008) concluded in his study that the fact that students were interested in the environmental issues and paid attention to these issues, and that students' parents who were well informed about this issue were interested in the environmental issues and involved in environmental activities led students to have interest, positive attitude and opinion about the environment.

It was concluded that teacher candidates did not have any opinion on the location of nuclear power plants planned to be established in our country before

the trip and that teacher candidates with opinions did not have clear opinions about why it could be the right location or why it could not be the right location. After the trip, it was seen that there was a significant increase in the number of teacher candidates who expressed opinions about the fact that the locations of nuclear power plants planned to be established in our country could be the right locations. This can be interpreted that the guidance of the faculty member working in ITU Energy Institute during the trip affected the planned technical trip made.

Although the majority of teacher candidates expressed opinion for the establishment of nuclear power plants away from the city center before the trip concerning the properties of the locations where nuclear power plants could be established in our country, almost all teacher candidates expressed opinion after the trip that the fact that nuclear power plants to be built in our country are far away or close to the city center was insignificant, the most important thing was that they should be established in locations near water resources. This finding is interpreted that information about the fact that the reactor should be cooled and information about the fact that locations near water resources would be the reason for preference in this cooling given by faculty member working in ITU Energy Institute in his presentation to teacher candidates could be effective in this great change in teacher candidates' opinions.

Before the trip, while almost all teacher candidates expressed an opinion as energy supply concerning the benefits of nuclear power plants, only one person expressed an opinion as technological development. However, an increase in the opinions concerning the country's development (national economy, nuclear weapon production, nonconsumption of natural gas, nonconsumption of fossil fuel, conservation of natural resources) can be interpreted as the effect of the trip. Also, the emergence of an opinion regarding the work area can be interpreted that teacher candidates thought a new business opportunity door would be opened with a nuclear power plant to be established.

It was seen that the majority of teacher candidates expressed radiation to be the greatest harm in nuclear power plants before the trip, and it was observed there was a decrease in this opinion and opinions expressing that it was not harmful emerged after the trip. It can be said that the fact that the faculty member in charge measured radiation in the environment when he was next to the reactor and stated that the amount of radiation measured was at the level that could be considered normal by giving examples from everyday life could be the reason for this. Also, it was seen that the opinions on a nuclear bomb, explosion risk and the absence of its harm emerged after the trip.

When the information resources related to nuclear power plants were examined before the trip, it was seen that undergraduate courses including the media (newspapers, the Internet, TV) were effective in the formation of teacher candidates' opinions. This can be interpreted that the media affect the society. It was seen that all teacher candidates who participated in the trip (17) stated the trip to be a more reliable information source after the trip, and this result is interpreted in a way that investigating subjects on site through trips is more effective. Similarly, Ay, Anagün, and Demir (2015) achieved opinions in their study that out-of-school learning ensures that students experience an effective life in the configuration of information.

When teacher candidates' opinions concerning the effect of nuclear power plants on the environment before the trip were examined, its harm such as air and water pollution, nuclear waste, loss of fertile land, the effects on human health and especially radiation is in question. This result that shows parallelism with the finding in the table of the opinions concerning the harm of nuclear power plants increased the opinion indicating that nuclear power plants have no harm after the trip. Also, it was seen that the frequency of those who expressed the opinion that radiation might have effects on the environment before the trip decreased after the trip. This result is interpreted in a way that the concept of radiation is misknown. In their study carried out concerning the modeling of radioactive decay, Bakaç, Taşoğlu and Uyumaz (2011) concluded that students' preliminary information concerning the use of the related concept in nuclear physics in their models was insufficient, and the graphics they drew again after the training given included more accurate values.

When teacher candidates' opinions concerning the nuclear wastes before the trip were examined, while misinformation about the fact that nuclear power plants don not have waste was expressed by a teacher candidate, all of the participants stated after the trip that the waste generated could be stored and evaluated. Additionally, it was seen that although the number of teacher candidates without opinions on nuclear waste was quite high before the trip, an opinion concerning the fact that nuclear waste is harmless and even the waste generated is valuable emerged after the trip. The presentation made by the faculty member in charge during the technical trip was thought to be effective in this.

It is seen that half of candidate teachers' opinions on nuclear power plants to be established in our country were negative before the trip. However, opinions of the same candidate teachers were positive after the trip. Also, it is seen that a teacher candidate expressed a negative opinion before the trip and then expressed an indecisive opinion, and that three teacher candidates expressed an indecisive opinion before the trip and then expressed a positive opinion after the trip. Also, it is seen that opinions of two teacher candidates expressing a negative opinion before the trip did not change after the trip. And although two teacher candidates expressed a positive opinion before the trip, they expressed an indecisive opinion after the trip. Briefly, it is revealed that candidate teachers' opinions on nuclear power plants to be established in our country changed for the establishment of nuclear power plants in our country by the effect of the technical trip made. This result can be explained by the fact that teacher candidates did not have sufficient information about the locations where nuclear power plants would be established in our country and about how these locations are determined, and that their information increased after the trip.

Suggestions

It can be said that the importance of the media's objectivity should be presented considering the fact that it affects the people's opinions concerning the socio-scientific issues such as nuclear power plants.

Research on the concept of radiation should be performed.

More detailed and healthy investigation of teacher candidates' attitudes and opinions was made possible as a result of gaining first-hand experience by taking them to the real reactor during the technical trip. The fact that teachers

who are both role model and a guide for elementary and secondary school students present concrete experiences in different ways in this way will provide insight for them to configure information.

Disclosure statement

Some part of this research was presented as a verbal statement at the 1st National Physics Education Congress held in Hacettepe University.

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References

- Ay, Y., Anagün, Ş.S. ve Demir, Z.M. (2015). Sınıf Öğretmeni Adaylarının Fen Öğretiminde Okul Dışı Öğrenme Hakkındaki Görüşleri. *Turkish Studies International Periodical for the Languages, Literature and History of Turkish or Turkic*, 10, 103-118. ISSN: 1308-2140.
- Bakaç, M., Taşoğlu, K. A. ve Uyumaz, G. (2011). Modeling Radioactive Decay. *Procedia - Social and Behavioral Sciences*, 15, 2196–2200.
- Boyes, E., & Stanisstreet, M. (1991). Misconceptions in first-year undergraduate science students about energy sources for living organisms. *Journal of Biological Education*, 25(3), 208-214.
- Bozdoğan, A. E. (2007). *Bilim ve teknoloji müzelerinin fen öğretimindeki yeri ve önemi. Gazi Üniversitesi Eğitim Bilimleri Enstitüsü İlköğretim Bölümü, Ankara.* (Yayınlanmamış Doktora Tezi).
- Bozdoğan, A.E. ve Yalçın, N. (2006). Bilim Merkezlerinin İlköğretim Öğrencilerinin Fene Karşı İlgi Düzeylerinin Değişmesine Ve Akademik Başarılarına Etkisi: Enerji Parkı. *Ege Eğitim Dergisi*, (7)2: 95–114
- Braund, M. ve Reiss, M. (2006). Towards a More Authentic Science Curriculum: The contribution of out-of-school learning. *International Journal of Science Education*, 28(12), 1373–1388.
- Brown, J. M., Henderson, J. ve Armstrong, M. P. (1987). Children's perceptions of nuclear power stations as revealed through their drawings. *Journal of Environmental Psychology*, 7(3), 189–199.
- Ediger, V. ve Kentmen, Ç. (2010). Enerjinin toplumsal boyutu ve türk halkının enerji tercihleri. *Mülkiye*, 34(268). 156-167.
- Ertaş, H., Şen, A.İ. ve Parmasızoğlu, A. (2011). Okul Dışı Bilimsel Etkinliklerin 9. Sınıf Öğrencilerinin Enerji Konusunu Günlük Hayatla İlişkilendirme Düzeyine Etkisi. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, 5(2), 178-198.
- Flexer, B. K. & Borun, M. (1984). The impact of a class visit to a participatory science museum exhibit and a classroom science lesson. *Journal of Research in Science Teaching*, 21(9), 863 - 873.
- Fraenkel, J. R. & Wallen, N. E. (1996). *How to design and evaluate research in education*. New York: McGraw Hill.
- Gürdal, A., Bayram, H. ve Şahin, F. (1999). İlköğretim öğretmen adaylarının enerji konusunda bütünlüğü sağlama ve ilişki kurma düzeyleri üzerine bir araştırma. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi*, 10, 382-395.
- İstanbul Teknik Üniversitesi Nükleer araştırma reaktörü. URL: <http://www.enerji.itu.edu.tr/Icerik.aspx?sid=9556>. adresinden 10.11.2012 tarihinde alınmıştır.
- İşeri, B. (2012). *Fen ve teknoloji öğretmen adaylarının nükleer enerjinin riskleri ve faydaları hakkındaki düşüncelerine farklı bilgi kaynaklarının etkileri*. Yüksek Lisans Tezi, Ahi Evran Üniversitesi, Kırşehir.
- Jin, H. & Anderson, C. W. (2012). A learning progression for energy in socio -ecological systems. *Journal of Research in Science Teaching*, 49(9), 1149-1180.

- Karabulut, E. (1999). *Enerji kaynakları*. Ankara: Ankara Üniversitesi Basımevi.
- Karagöz, C. (2007). *Kimya öğretmen adaylarının nükleer enerjiye karşı ilgi ve tutumları*. Yüksek Lisans Tezi, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.
- Kolsto, S. O., (2000). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socioscientific issues. *Science Education* 85, 291-310.
- Korpan, C. A., Bisanz, G. L., Bisanz, J. & Henderson, J. M. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education*, 5, 515-532.
- Ökesli, T. F. (2008). Relationship between primary school students' environmental literacy and selected variables in Bodrum. Yayımlanmamış yüksek lisans tezi. Ankara: Orta Doğu Teknik Üniversitesi, Fen Bilimleri Enstitüsü.
- Özdemir, N. ve Çobanoğlu, E.O. (2008). Türkiye'de nükleer santrallerin kurulması ve nükleer enerji kullanımı konusundaki öğretmen adaylarının tutumları. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 34, 218-232.
- Pedretti, E. G. (2004). Perspectives on learningthrough research on critical issues-based science center exhibitions. *Science Education*, 88, 34– 47.
- Ramey-Gassert, L. (1997). Learning science beyond the classroom. *The Elementary School Journal*, 4, 433-450.
- Rizaki, A. & Kokkotas, P. (2013). The use of history and philosophy of science as a core for a socioconstructivist teaching approach of the concept of energy in primary education. *Science & Education*, 22(5), 1141-1165.
- Sağlam-Arslan, A. (2010). Cross-grade comparison of students' understanding of energy concepts. *Journal of Science Educational Technology*, 19, 303-313.
- Tobin, R. G., Crissman, S., Doubler, S., Gallagher, H., Goldstein, G., Lacy, S., Rogers, C.B., Schwartz, J. & Wagoner, P. (2012). Teaching teachers about energy: Lessons from an inquiry-based workshop for K-8 teachers. *Journal of Science Education And Technology*, 21(5), 631-639.
- Tortop, H. S. (2007). Üstün yetenekli öğrencilerle yenilebilir enerji kaynakları ile ilgili anlamlı alan gezisi. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, 12(1), 181-196.
- Yıldırım, A. ve Şimşek, H., (2003). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayıncılık. 3. Ankara: Baskı.
- Yönev, M. (2008). *Ortaöğretimde okutulan tarih derslerindeki gezi gözlem ve inceleme etkinliklerinin öğrenciler açısından kazanımları*. Yüksek Lisans Tezi, Yeditepe Üniversitesi, Sosyal Bilimler Enstitüsü, İstanbul
- Yürümezoğlu, K., Ayaz, S. ve Çökelez, A. (2009). İlköğretim ikinci kademe öğrencilerinin enerji ve enerji ile ilgili kavramları algılamaları. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi* 3(2), 52-73.