

VIEWS AND KNOWLEDGE OF PRESERVICE SCIENCE TEACHERS ABOUT NUCLEAR POWER PLANTS

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ABSTRACT

The world is facing with problems having three aspects which are energy, economy and environment. These problems are generally controversial. In recent years Turkey also encounters such a controversial issue and decision making on this issue seems difficult. The government is planning to construct a nuclear power plant on the south part of Turkey. Nuclear energy is considered as one of the science and technology issues for which there is a debate between specialists and public. Therefore in this study, we investigated the views and knowledge of preservice science teachers about nuclear power plant using a quantitative method. The instruments were developed by the researcher and both had a good internal consistency. The results showed that preservice science teachers had negative views about construction of nuclear power plant and were knowledgeable at a moderate level.

Key Words: Views on nuclear power plant, preservice science teacher, knowledge about nuclear power plant.

INTRODUCTION

The world is facing with problems having three aspects which are energy, economy and environment and the basic concern is to solve the problems through balancing these aspects (Powell, Robinson, Pankratius, & Pankratius, 1994). When someone struggle to find solution to one of these problems, another problem evokes. This makes the problems controversial and problems turns to an issue. Controversial social issues are called as socioscientific issues and they are not easy to solve (Sadler, Barab, & Scott, 2007). In recent years, Turkey also encounters such a controversial issue and decision making on this issue seems difficult. The government tries to find alternative ways to meet the increasing energy demand. For that purpose, three nuclear power plants construction is on the agenda of the government. Actually, while we were penning this document, Turkey launched the construction of first nuclear power plant in Mersin-Akkuyu. Some argue that it should be constructed while others reject its construction. Some people and organizations focus on the effects of nuclear power plants on environment and living organisms while some people and the government considers the benefits of nuclear power plants on energy demand and economy. As a result of this, people take different positions on nuclear power plant construction. To take a decision on this issue requires time and effort in addition to the required skills for decision making. Social studies educators reported that dealing with controversial issues is particularly a significant problem (Shillenn, 1981). Pouliot (2008) also stated that the study of such controversial issues "will prompt young people to familiarize themselves with science in action, to develop their capacity for evaluating the information made available to them on a daily basis, to make decisions concerning controversial sociotechnical issues, and to take part in debates and discussions on sociotechnical controversies of concern to them" (p. 545). Based on these skills and their positions, individuals can make a decision on controversial issues. The position a person takes usually depends on his views about nuclear energy. Views about nuclear power plant in Turkey clearly become very important because energy demand, economic independence, and intuition to protect environment are fighting against each other.

Nuclear Energy

The history of nuclear studies goes back to the last decade of nineteenth century through nuclear physics studies. Raymond LeRoy (2001) states that the modern era of nuclear physics emerge by the following studies; ionization of a gas by means of electric discharge by Crookes in 1879, discovery of penetrating X-rays from a discharge tube by Roentgen in 1895, discovery of Gama-rays from the element uranium which exhibited the phenomenon of radioactivity by Becquerel in 1896, identification of electron as the charged particle of atom responsible for electricity by Thomson in 1897, and the isolation of radioactive element radium by Curies in 1898. Under laboratory conditions, first nuclear reaction occurred in University of Chicago in 1942 (Pekoz, 2006). Pekoz stated that first nuclear reactors emerged due to the cold wars between USA and Soviet Union. Experimental Breeder Reactor 1 was the first experimental plant constructed in Idaho-USA. It was the first to produce electrical energy from nuclear energy in 1951. The first civilian nuclear-based electrical energy production was accomplished in the Soviet Union in 1954.

Based on International Atomic Energy Agency data, as of 2015, there are 443 operational nuclear reactors in the world with a further 66 under construction. With 99 nuclear power plants, the USA utilizes from nuclear energy most by producing 19.47 % of its total electricity. France was the second country having 58 nuclear power plants and meeting 76.93 % of the electrical energy production (IAEA, 2015). Table 1 gives the number of nuclear power plants worldwide (IAEA, 2015).

Table 1: Number of Reactors Worldwide

Country	Total Reactor
United States of America	99
France	58
Japan	48
Russia	34
China	27
Korea, Republic of	24
India	21
Canada	19
United Kingdom	16
Ukraine	15
Sweden	10
Germany	9
Belgium	7
Spain	7
Czech Republic	6
Switzerland	5
Finland	4
Hungary	4
Slovakia	4
Argentina	3
Pakistan	3
Brazil	2
Bulgaria	2
Mexico	2
Romania	2
South Africa	2
Armenia	1

Iran, Islamic Republic of	1
Netherlands	1
Slovenia	1
<i>Total</i>	<i>443</i>

Table 2 gives the major nuclear reactor accidents across country. Chernobyl nuclear reactor accident was the most known one since its detrimental effects still continues.

Table 2: Nuclear Power Plant Accidents in the World

Year	Country
1952	Canada—Chalk River
1957	Soviet Union—Mayak or Kyshtym nuclear complex
1961	U.S.—Idaho Falls
1979	U.S.—Three Mile Island
1986	Ukraine—Chernobyl
1995	Japan—Monju
2011	Japan—Fukushima

Even these accidents had detrimental effects; countries insist on constructing nuclear power plants. Turkey is one of those countries which attempt to construct nuclear power plants. Nowadays in Turkey, there is an effort for the construction of nuclear power plant by government. But the nuclear power plant initiatives in Turkey are not new. There have been lots of attempt through our near past. The chronological attempts of nuclear energy in Turkey are as follows:

- In 1955, Turkey signed an agreement with the USA to cooperate with the “peaceful uses of nuclear energy.”
- In 1956 the Turkish Atomic Energy Commission (TAEK) was established.
- In 1960, the Kucukcekmece power plant put into frame.
- In 1974, the government developed a nuclear power plant project for Mersin Akkuyu.
- In 1976, the plan of Akkuyu project was chosen for a power plant construction again.
- In 1983, the government took the Akkuyu project in the agenda again.
- In 1986, the Chernobyl accident occurred.
- In 1987, nuclear energy department was closed down after Chernobyl accident.
- In 1993 Akkuyu Nuclear Plant project was published again in the official newspaper and were included in the investment program of the government.
- In 2000 Prime Minister announced nuclear energy plans waived because of being expensive.
- In 2006, the city of Sinop was selected as Turkey's first nuclear power plant site.
- In 2010, Turkey and Russia signed agreement for Akkuyu Nuclear Power Plant (CNNTurk, 2010; Ntvmsnbc, 2009; Pekoz, 2006; Yenisafak, 2010).

Especially within last ten years, the debate on nuclear power plant proliferated due to more serious and concrete steps of government toward nuclear energy. In the past environmentalist and the government debates was dominant but now in addition to these organizations other governmental and non-governmental organization including politicians, newspapers, magazines, and TVs included in the debate. One side advocates that Turkey will have energy shortage in near future and imported oil and natural gas will not be sufficient to meet the energy demand. Moreover the supporters of nuclear energy argued that although the operation of nuclear reactors demonstrated as “victim”; developed countries use this energy in every field of life such as medicine, research, and industry. In addition to these arguments, nuclear energy was suggested as the only option for issues such as sustainable development and global warming. Although solar energy, and wind energy is presented to be more effective than nuclear energy in terms of sustainable development and global warming, huge areas should be allocated for solar panels to meet the energy need of a country having almost 78 million individuals. Also, the efficiency of wind and solar energy depends on air conditions.

As oppose to these, environmental organizations emphasized that nuclear power plant should be abolished in a country that has unsolved waste problem, back and risky technology, 25 % energy lost, lacking of energy policy considering environmental problems. The opponents of nuclear energy refers to the minor and major nuclear accidents and radiation leakages in countries including the United States, United Kingdom, Japan, and Russia, resulting in serious consequences such as cancer, congenital anomalies and even deaths. More importantly, the effects of nuclear accidents last for decades and can reach hundreds of kilometers away. Nuclear power plants are not totally free from accidents due to structural reasons. Moreover nuclear power plants produce hundreds of tons of highly radioactive waste during their operations and this waste emits radiation for thousands of years. Unfortunately it is not found a safe way to store radioactive wastes without emitting radiation.

METHODOLOGY

Research Problem

In this paper, preservice science teachers' views and knowledge about nuclear power plant were investigated by means of collecting data through two different instruments. More specifically the following research questions guided this study.

1. What are the views of preservice science teachers concerning the construction of nuclear power plant in Mersin?
2. To what extents are preservice science teachers knowledgeable about nuclear power plants?

Participants and Data Collection

In this study, a quantitative research method was used to establish the views and knowledge of preservice science teachers concerning the construction of nuclear power plants. Convenient sampling was used. The sample included 33 preservice science teachers enrolled in elementary science teacher education program in one of the well-known universities in Ankara. Twenty-six of them were female and remaining 7 of them were male. The demographic information of the participants is given in Table 3.

Table 3: Demographic description of the sample

Demographic Category		Frequency (f)	Percentage (%)
<i>Gender</i>	Female	26	78.8
	Male	7	21.2
<i>Having Environment Education</i>	Yes	27	81.8
	No	6	18.2
<i>Follow environmental publication, broadcast etc.</i>	Never	1	3.0
	Rarely	2	6.1
	Sometimes	11	33.3
	Usually	19	57.6
	Always	0	0.0
<i>To be a member of any environmental organization</i>	Yes	9	27.3
	No	24	82.7
<i>The number of participation in environmental activities</i>	Never	12	36.4
	1-2 times	10	30.3
	3-4 times	5	15.2
	5 and more	6	18.2

In this paper, two instruments were developed by the researcher. In developing the instrument, the information given in the news, media, reports of governmental and non-governmental organizations and articles were collected. A total of 22 items were included in the first instrument which measured participants' views about nuclear power plants. The second instrument included 14 items which measured participants'

knowledge about nuclear power plants. The first instrument was a 5 point-Likert type instrument in which 1 refers to *strongly disagree*, 2 refers to *disagree*, 3 refers to *undecided*, 4 refers to *agree* and 5 refers to *strongly agree*. Second one is 3 point knowledge scale in which 1 refers to *yes*, 2 refers to *no*, and 3 refers to *not sure*. Both instruments were administered to 33 participants. In light of the results of the reliability analysis, both of them have good internal consistency with a Cronbach Alpha coefficient of .93 and .87 respectively. The instruments were given in Table 4 and 5.

RESULTS

When the data was examined, it was found that preservice science teachers hold negative views about the construction of nuclear power plant in general. In the same vein, it is not interesting that the highest mean score obtained in question 11 with a mean score 4.36. The item was "Instead of nuclear power plant, the renewable (wind, solar) energy sources should be considered in Mersin". It is clear that PSTs prefer use of renewable energy sources to meet energy need.

Table 4: The Mean Scores of Items of Views about Nuclear Power Plant

Items on Views about Nuclear Power Plants Instrument	Mean Scores
Nuclear power plant which will be constructed in Mersin can lead to social problems.	4.09
Nuclear power plant which will be constructed in Mersin region may lead to public health problems.	4.21
Nuclear power plant which will be constructed in Mersin can damage the natural beauty.	4.15
Nuclear power plant which will be constructed in Mersin may damage the surrounding green areas.	4.03
Nuclear power plant which will be constructed in Mersin will provide job opportunities for the local public.	3.24
Nuclear power plant which will be constructed in Mersin may damage animal species in the surrounding environment.	4.15
Nuclear power plant which will be constructed in Mersin may damage species of plants in the surrounding environment.	4.12
Nuclear power plant which will be constructed in Mersin may result in visual pollution.	3.90
Nuclear waste may be a problem in Mersin.	3.90
10. Nuclear power plant can make Mersin open to terrorist attacks.	3.90
11. Instead of nuclear power plant, the renewable (wind, solar) energy sources should be considered in Mersin.	4.36
12. We should not stay away from nuclear energy.	2.93
13. Nuclear power plant should be established as soon as possible to solve future energy problems.	2.48
14. Nuclear power plants should be supported due to production of cheap energy.	2.60
15. Nuclear power plants should be constructed because energy gives direction to politics among countries.	2.60
16. Energy is among the indicators of being a developed country so nuclear power plant should be constructed in Mersin.	2.30
17. Energy is required for research and development facilities so nuclear power plant is necessary in Turkey.	2.67
18. I am not interested in nuclear power plant which will be constructed in Mersin.	1.88
19. The nuclear accidents in the past make me worried about nuclear power plant.	3.66
20. The connection between nuclear power plants and nuclear weapons makes me worried about nuclear power plants.	3.45
21. The ambiguity in the nuclear waste management in future makes me worried about nuclear power plant.	4.30
22. The fact that the effects of nuclear power plants are transferred to the next generations makes me worried about nuclear power plants.	4.33

Next, question 22 got the second highest mean ($M = 4.33$). Apparently, PSTs are afraid of the consequences of a nuclear accident because devastating effects of nuclear disaster transferred from generation to generation. Indeed, in question 21, participants also reported that they are anxious about the mystery of nuclear waste for future (with a mean of 4.30).

In question 18, participants were asked whether they are deaf to nuclear power plant construction in Mersin or not. The lowest mean score were obtained in this question as 1.88. This demonstrates that the PSTs are not insensible on the issue. The item "Energy is among the indicators of being a developed country, so nuclear power plant should be constructed in Mersin" had the second lowest score among participant. The mean score of this item was 2.30. It can be inferred that PSTs are doubtful about the nuclear energy to be an indicator of development. Correspondingly, the item "Nuclear power plant should be established as soon as possible to solve future energy problems" got 2.48 mean score from the participants of the study. This item can be interpreted in two ways; PSTs do not either believe in energy shortages in Turkey, or they are against nuclear power plant construction. Perhaps they both do not believe in energy shortages, and they are against nuclear power plant construction. Whatever the real reason, they do not want a nuclear power plant in Mersin-Akkuyu. To sum up, it can be concluded that the PSTs have negative views about nuclear power plant construction in Akkuyu.

The summary of knowledge test is shown in Table 5. In general their knowledge was good in terms of nuclear power plant and nuclear energy. In question 5 and 6, they were asked "Nuclear power plants are expensive to deconstruct" and "It is difficult to store nuclear waste" respectively. All the participants answered these two questions correctly. They seemed to be aware of the economic burden of removing nuclear power plants. Similarly, it is not strange to know about storage difficulty of nuclear waste because most of the time it is mentioned in news and magazines. The two items which are; "Nuclear power plants are expensive to build" and "Chernobyl disaster was the result of human error" had the second highest correct answer from the participants.

Table 5: The Frequency of Participants' Answer on Knowledge Test

Knowledge of Nuclear Power Plant Test	True (freq.)	False (freq.)	Not sure (freq.)
When the same amount used, nuclear fuel gives more energy as compared to the other sources (coal, oil, etc.).	30*	2	1
Nuclear power plants are expensive to build.	32*	1	0
When the unit price increases, the consumers pay more for nuclear energy as compared to other energy sources.	6	10*	17
Nuclear power plants do not have a lifetime.	1	31*	1
Nuclear power plants are expensive to deconstruct.	33*	0	0
It is difficult to store nuclear waste.	33*	0	0
Nuclear power plants requires expertise.	30*	0	3
It is quick to build nuclear power plants.	0	26*	7
Nuclear power plants release the most amount of carbon dioxide to the environment.	3	27*	3
10. Nuclear power plants significantly reduce the energy shortage.	26*	4	3
11. Nuclear power plants are one of the solutions to global warming.	22*	8	3
12. Natural sources account for most of the radiation we all receive each year.	13*	20	0
13. In terms of science and technology, less developed countries than us have already nuclear power plants (e.g. Pakistan)	29*	0	4
14. Chernobyl disaster was the result of human error.	32*	0	1

* Represents the true answer of the questions.

PSTs know less about the reflection of unit price increase on the economy. Only 10 of 33 participants answered the question 3 correctly. This result also is not surprising because in Turkey, few know about the prices of

energy sources and authorities seldom inform citizens about the pricing of such sources. It is really interesting that the amount of radiation emitted by nuclear power plants are less than the amount of radiation we are exposed to in nature. In the study the PSTs knew less about this issue as well and just 13 of 33 participants answered it correctly.

CONCLUSION AND RECOMMENDATIONS

Nuclear energy is considered as one of the socioscientific issues (SSI) for which there is a debate among specialists and public and a lot of research was carried out to reveal factors that influence public acceptance of nuclear energy (Komiya, Torii, Fujii, & Hayashizaki, 2008). This study was conducted with preservice science teachers to explore their views and knowledge about nuclear power plant. PSTs' views and knowledge about a socioscientific issue (nuclear power plants in this study) is not only important for their personal decisions but also for their profession as a teacher since they will teach such topics in their future classrooms. They can assist their students to develop scientific literacy and to be a scientifically literate individual. Their students may be the future politicians, businessman, engineers who have to make decisions. PSTs engagement with SSI during their teacher education programs may provide them with necessary knowledge and skills to integrate SSI into science education. Therefore, they may help their students to gain necessary knowledge and skills to make informed decisions on science related societal issues. SSI has provided a new image for science education focusing on the students' involvement in real-life social problems based on science (Sadler & Fowler, 2006). When the science is isolated from socioscientific issues, students do not develop necessary skills and practices and gain necessary knowledge to use in response to the real life problems including social dilemmas (Sadler & Zeidler, 2005). As being a member of a society, they will ultimately encounter with such conflict issues at a point in time. Therefore SSI movement in school science is an opportunity to practice skills and knowledge to resolve real life problems. The integration of socioscientific issues into science education was discussed by researchers because it is vital in terms of the development of good citizens who are aware of scientific knowledge (Driver, Newton, & Osborne, 2000; Kolstø, 2001). With the international reforms in science education, Turkey also acknowledged recent reform movements in the current science and technology curriculum. The vision of science and technology curriculum was stated to educate all students as scientifically literate individuals without considering the individual differences (MoNE, 2013). The new curriculum proposed that scientific literacy has seven aspects one of which emphasizes the relation between science, technology, society, and environment. One of the characteristics of scientifically literate individuals was stated as being able to relate science, technology, and society and to use the knowledge, understanding, and skills gained in solving problems and making decisions. In 2013, the national science and technology curriculum has undergone several revisions to integrate socioscientific issues into the science education. One of the goals of science education was stated as "to develop habits of mind through the use of socioscientific issues" (MoNE, 2013). In order to develop habits of mind such as acquiring skepticism, maintaining open-mindedness, evoking critical thinking, recognizing multiple forms of inquiry, searching for data-driven knowledge (Zeidler, Sadler, Simmons, & Howes, 2005), students should participate in socioscientific reasoning and decision making process. Therefore the classroom activities should be designed to achieve this goal. In order to use SSI in parallel with the goals of science education, science teachers should also have the necessary knowledge. Therefore this study has value in preservice science teacher education.

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