Pre-Service Science Teachers' Views about Nuclear Energy with Respect to Gender and University Providing Instruction

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ABSTRACT: The purpose of this research was to investigate pre-service science teachers' (PST) views about nuclear energy and to examine what effects, if any, of gender and the university of instruction had on their views. Data were collected through the Risks and Benefits about Nuclear Energy Scale (İşeri, 2012). The sample consisted of 214 PSTs who enrolled in the faculties of education at Ahi Evran University (n= 100) and Erciyes University (n= 114) in Turkey. Findings revealed that the majority of PSTs believed that nuclear energy is useful and almost all participants supported nuclear energy when it concerns electricity and energy generation, national defense and prestige in the international community. Additionally, according to the results of two-way MANOVA analysis, while there was a statistically significant difference regarding the university of instruction, there were no significant differences between genders in both the risk and benefit dimensions. While the eta squared statistic showed a small effect size for the gender variable, a large effect size emerged for the university variable.

KEY WORDS: Nuclear Energy, Views of Pre-Service Science Teachers, Benefit, Risk

INTRODUCTION

Although discussions related to whether the use of nuclear energy is acceptable have been in progress in Turkey since 1950, nuclear power is widely used in other countries such as the United States and France (İskender, 2005). The education and energy policies of a society need to reflect an industrial, technological, cultural and social basis. This includes having a sense of responsibility by communities deriving from adequate trained individuals (Karagöz, 2007) having positive views towards the environment and energy breakthroughs to be achieved in accordance with developments. However, nuclear energy is not well featured in the Turkish science education curriculum. As a result, very limited information about nuclear energy is included at the primary school level

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(grades 1-8) and nuclear energy is taught mainly in physics and medicine at the university level (Özdemir & Çobanoğlu, 2008).

According to the science curriculum prepared by Head Council of Education and Morality in 2013, the subject of nuclear energy is taught mainly in the Human and Environment unit in the 7th grade. The relationship between nuclear energy and the environment is taught in the 3rd grade in the science education teacher education (preservice) curriculum.

Although there have been numerous studies on energy sources (Foskolos, Yadigaroğlu, & Chawla, 1996; Gurung, Gurung, & Oh, 2011; Kılınç, Stanisstreet, &Boyes, 2009; Liarakou, Gavrilakis, &Flouri, 2009; Yumurtacı & Keçebaş, 2011), the number of studies that investigated pre-service science teacher's (PSTs') opinions relating to nuclear energy were limited. In the study conducted by Ates and Saracoglu (2013), researchers interviewed 10 PSTs revealing that participants' views were negative about the impact of nuclear power plants on living beings and the environment. Additionally, PSTs believed that if the necessary measures were not taken, nuclear waste could diffuse into the groundwater as well as radioactive substances leaking into the environment due to a nuclear accident. A further point, highlighted in the Ateş and Saraçoglu study, was that PSTs believed that infants and children could get cancer because of the harmful effects of radiation. In another study, Özdemir and Coban (2008) examined the differences occurring between boys and girls on issues such as the establishment of nuclear power plants in Turkey, the effects of nuclear power plants on the environment, and Turkey's energy policies. According to their results, significant differences were found in terms of gender in all of the topics. It was stated that the attitudes of male PSTs appeared to be more positive than females. Similarly, in the study conducted by Kilinc, Boyes and Stanisstreet (2012), significant differences emerged between boys and girls. Nuclear energy was supported more by boys with respect to economics, while, girls did not support nuclear as it has a negative impact on nature. Tekbıyık and Ipek's (2008) study also reported that males supported nuclear energy more than females. There seemed to be a relationship between gender and attitudes towards nuclear energy (Davidson & Freudenburg, 1996; Keller, Visschers, & Siegrist, 2012; Mobley & Kilbourne, 2013; Stern, Dietz, & Kalof, 1993; Whitfiel, Rosa, Dan, & Dietz, 2009). Simon (2013) stated that this gender difference concerned the social role and value of nuclear energy.

It has been considered that one of the differences that may occur among PSTs is the university variable even though the same science curriculum is used in almost all Turkish universities. According to Bolay (2011), the university is a place where learning takes place alongside research, development, and in a spirit of co-operation. The contemporary

university must have a scientific mindset, be able to follow the world literature, have a very rich library and documentation center (Bolay, 2011). Therefore, some of the factors contributing to the difference in quality between universities include their physical, academic and social facilities as well as the quality of their teaching staff. In addition, the facilities of the cities from which students dwell, such as social, economic and education, may influence PSTs' ideas. In a study conducted by Özdemir and Coban (2008), investigating differences of PSTs' views based on the geographical area where they received their pre-university education, inhabitants of regions where small cities are more common have more positive views than inhabitants in areas where there are larger cities.

With the signing of agreements on operation of nuclear power plants in the city of Mersin in 2010 and Sinop in 2013, nuclear energy is an issue in Turkey. Thus, it needs to also occupy a meaningful place in science education. With this in mind, the views of PSTs to be involved in teaching when these nuclear power stations are completed need to be examined.

The purpose of this research was to investigate the views of prospective primary school teachers (i.e. preservice teachers - PSTs) who were enrolled in the department of science education about nuclear energy and to determine whether there were differences based on gender and the University offering instruction. The nuclear energy topic was included in the course of Special Topics in Chemistry and Environmental Science that contained a relationship between nuclear energy and the environment in the 3rd year of the PST's science education curriculum. Consequently, participants of this study had sufficient knowledge to respond to the study's survey instrument.

RESEARCH QUESTIONS

The two research questions guiding the study were:

1. What are pre-service science teachers 'views about nuclear energy?
2. Are there any significant differences regarding pre-service science teachers' views about nuclear energy with respect to gender and university of instruction?

METHODOLOGY

Sample

The sample of this study was determined by purposive sampling, since the investigators used personal decisions in order to choose a sample (Fraenkel, Wallen, & Hyun, 2012). The sample consisted of 214 students

in the 3rd year of their study who enrolled in the department of science education at Ahi Evran University (N: 100, 47%) and Erciyes University (N: 114, 53%) in Turkey. The study included 59 males and 155 females with the mean age of 21.89 (participants' age range: 18-26).

Instruments

The participants responded to 30 items in the survey instrument 'Risks and Benefits of Nuclear Energy Scale' (RBNES) (Iseri, 2012), which included demographic questions regarding age, gender and university of instruction.. Each item had 5 responses ranging from "strongly agree" to "strongly disagree". A pilot study was conducted at Ahi Evran University to determine the reliability and validity of the survey instrument. To measure the internal consistency of the variables (Trumper, 2006), the alpha coefficient was calculated and was found to be .80, which indicates high reliability (Kalaycı, 2006). The survey was presented to participants in Turkish, but responses have been given here in English. For the content validity of the data, experts were consulted and factor analysis was conducted.

Data Collection

The data in the current study were collected in the 2012-2013 spring semester. Ethical permission from the Ethical Committees at Ahi Evran University and Erciyes University were obtained prior to conducting the study. A signed consent form was returned by the participating PSTs in order to confirm that they voluntarily agreed to participate in this study. To ensure consistency in data collection, the first author administered the survey. The survey took approximately 15 minutes to complete.

Data Analysis

The data were analysed by means of factor analysis. To learn whether data were suitable for factor analysis, the values of Kaiser-Meyer-Oklin (KMO) and Barlett test were examined. Since the Kaiser-Meyer-Oklin value of RBNES was .80, which was above the recommended value of .60 and the Barlett's Test of Sphericity values were significant, the data were determined to be suitable for factor analysis (Pallant, 2005).

Prior to two-way MANOVA analyses, the data were tested in accordance with the assumptions consisting of multivariate normality, independence of observations and homogeneity of variance-covariance matrices). Firstly, multivariate normality assumption was conducted. To check the assumption, Histogram and Skewness-Kurtosis values were examined. During the statistical process, since histogram showed normal distribution and Skewness-Kurtosis values were between -2 and +2, this

assumption was provided successfully (Pallant, 2005). Box's M value helps to check homogeneity of covariance matrices assumption and Levene's test controls homogeneity of variance assumption. Box's M value was not statistically significant (p= .07) indicating that covariance matrices were equal. Therefore, this assumption was not violated. In order to learn whether the variances were the same or different, Levene's test was used. Levene's test was significant for the risk ($F(3, 210)$ = 3.72, p = .012) dimension, while it was not significant for the benefit ($F(3, 210)$ = .52, p = .67) dimension. F values were not too large in either of the dimensions. Thus, homogeneity of variance-covariance matrices assumption, which was the second assumption, was established successfully. Thirdly, while the survey instrument was being administered, participants independently completed the survey instrument and did not share their views or influence the views of other participants. Independence of observations assumption was provided successfully.

FINDINGS

Pre-Service Teachers' Views about Items in Risk Dimension

Descriptive analysis was used in order to learn PSTs' views about nuclear energy in risk dimensions. Findings related to PSTs' views are indicated by using independent variables. These findings related to variables of gender (male, female) and university (Ahi Evran University, Erciyes University) are indicated respectively. Data indicate combined percentages of PSTs who 'strongly agree' or 'agree' with the risk dimension. Findings toward this analysis are displayed in Table 1.
One quarter (25%) of the PSTs thought that nuclear power plants pollute the environment. When considering individual's respective university, those who study at Ahi Evran University expressed this opinion above this average at 35%, while individuals at Erciyes University were more moderate at 17%.

The rate of PSTs who believed that a nuclear power plant would not reduce their local tourism activities was 38%. This increased to 46% with Ahi Evran University participants, and decreased to 31% at Erciyes University.

While almost one of every two PSTs (55%) considered that the warm water that nuclear power plants discharge threaten aquatic life, 62% of the PSTs from Ahi Evran University reported this compared to 48% from Erciyes University.

One in six PSTs (17%) believed that investment in nuclear energy prevents investment in renewable energy. However, when broken down by gender females gave more positive answers (20%) than their male counterparts (9%).

The percentage of PSTs who believed computer programs were not reliable was low at 10%. Also almost half of the PSTs (51%) considered that there was an uncertainty with regard to the storage of nuclear energy. As with many other items on the survey, this item also identified a difference in terms of respective universities (60%, Ahi Evran University compared to 49% Erciyes University).Nearly three-quarters of PSTs (76%) emphasized that investment costs of nuclear power plants are high. However, this rate increased in responses of males (81%) and the PSTs at Ahi Evran University (83%).In general, 70% of PSTs believed that nuclear power plants would not cause cancer in babies and children. However, this ratio varied by gender and university. Males (80%) were more positive than females (66%) and PSTs in Erciyes University (82%) were more positive than PSTs in Ahi Evran University (56%).

Moreover, the proportion of those who considered radioactive material could be leaked in a possible nuclear power plant accident was 71%. Nearly three-quarters of respondents (74%) believed that radioactive waste is dangerous to living things. This item highlights a significant difference between universities, with 79% of the participating PSTs at Ahi Evran University reporting this, while it was only 69% of the PSTs at Erciyes University.

The proportion of PSTs who considered that nuclear power plants could be destroyed in a natural disaster such as an earthquake or flood was 58%. PSTs who thought that dangerous weapons can be produced by using nuclear energy (75%) also believed that negative results might occur in case of possible accidents (78%). Males (80%, 80%) were less worried than females in both items (74% at Ahi Evran University while it was only 77% at Erciyes University. More than half of the PSTs (61%) who responded the items considered that transportation of nuclear raw materials is high cost.

Table 1. Investigation of Items about Risk Dimension in terms of Variables

		Gender		University	
	Average	Male	Female	Ahi Evran	Erciyes
Item no	(%)	(%)	(%)	(%)	(%)
1	25	22	26	35	**17***
4	38	36	39	46	**31***
5	55	51	56	62	**48***
6	23	24	32	27	**18***
9	17	**9***	20	19	**15***
12	10	9	10	13	**6***
14	41	36	43	57	**27***
17	51	51	51	60	**49***

18	76	81	74	83	70
23	50	58	47	58	**42***
24	30	20	34	44	**18***
25	71	66	73	74	68
28	74	75	73	79	**69***
30	58	64	55	58	58
31	78	80	77	76	79
39	61	68	59	61	61
40	75	**80***	74	79	72

*Differences between the responses of subsets of PST were investigated using two-way Multivariate Analysis of Variance(MANOVA) test. In order to understand which significant differences are in favor of whom, mean values were examined. PSTs' responses to substances which were significantly different were shown by bold type and asterisks * (p<0.05).*

Pre-Service Teachers' Views about Items in Benefit Dimension

Descriptive analysis was used in order to learn PSTs' views about nuclear energy in beneficial dimensions. Findings related to PSTs' views were indicated by using independent variables related to variables of gender (male, female) and university (Ahi Evran University, Erciyes University) (Table 2). .

Findings indicate that many PSTs believed that the amount of electricity generated from nuclear power plants was more than from other plants (83%) and nuclear power plants were able to produce electricity for a longer time (87%) than other energy sources. Similarly, the proportion of those who thought that nuclear power was able to produce electricity year-round was 76%. The majority of PSTs (87%) supposed that countries, which possessed nuclear weapons and nuclear technology have greater voice in the international arena. The proportion of PSTs who thought that having nuclear energy would reduce dependence on foreign countries was quite high (88%). Significant difference emerged in this item with regard to respective universities (85%; 91%).Many of the PSTs considered that nuclear power plants enabled industry and technology to develop in a country (85%). There was a significant difference between universities in this item (80%; 89%).

While a large number of PSTs thought that nuclear power plants were able to produce energy longer than the other plants (80%), the proportion of PSTs who considered that electricity generation from nuclear power plants was cheaper than other types of energy plants (58%) was slightly lower. The majority of PSTs (81%) believed that nuclear energy would provide the energy diversity by being an alternative to other energy sources. There was a significant difference between universities in this item (90%; 72%).

The proportion of PSTs who thought that the raw materials used in nuclear power plants when they were purchased would be used longer than the raw material in other plants constitutes about three quarters of respondents (73%). Significant differences emerged in terms of gender (80%; 70%) and university (65%; 80%).

Almost nine out of ten of PSTs (87%) believed that energy produced from nuclear power plants could be used for a long time. This percentage of individuals at Ahi Evran University (82%) was smaller than their counterparts at Erciyes University (92%).The proportion of PSTs who thought that nuclear energy was a good alternative to close the energy gap in developing countries such as Turkey was 85%. The percentage of individuals agreeing with this item at Ahi Evran University (78%) was smaller than in the individuals at Erciyes University (92%).

Table 2.Investigation of Items about Benefit Dimension in terms of Variables

| | Average | Gender | | University | |
		Male	Female	Ahi Evran	Erciyes
Item no	(%)	(%)	(%)	(%)	(%)
7	83	83	83	82	84
8	87	90	86	85	90
15	76	81	74	74	78
16	89	**90***	88	86	91
19	88	90	88	85	**91***
21	85	83	86	80	**89***
22	80	83	79	76	84
26	58	61	57	46	**69***
27	81	78	82	77	**84***
29	73	**80***	70	65	**80***
32	87	88	87	81	**92***
33	87	88	87	82	**92***
38	85	88	85	78	**92***
39	40	25	66	43	49

*Differences between the responses of subsets of PST were investigated using two-way Multivariate Analysis of Variance (MANOVA) test. In order to understand which significant differences were in favor of whom, mean values were examined. PSTs' responses to substance, which were significantly different, were shown by bold type and asterisks * (p<0.05).*

Differences in Gender and University with Respect to Pre-Service Science Teachers' Views

Two-way MANOVA was used in order to test for differences in gender and university of instruction with respect to PSTs' views about nuclear energy. Statistically significant differences were found in PSTs' mean scores for university (*Wilks' l* = 0.86, $F(2,209)$ = 17.11, p = 0.000), while there were no significantly difference in mean scores for gender (*Wilks' l* = 0.98, $F(2,209)$ = 1.85, p = 0.160). While the eta squared statistic showed a small effect size ($\eta2$ = 0.017) for gender, there was a large effect size for the university variable ($\eta2$ = 0.14) (Cohen, 1988). These values indicate that 1.7 % and of 14% of the multivariate variances of the dependent variables were accounted for by the gender and university variable, respectively (Table 3).

Table 3. Investigation of Significant Difference in the Variables of University and Gender

Variables	Wilks' λ	F	p*	η^2
University	0,86	17,11	0,000	0,141
Gender	0,98	1,85	0,160	0,017

Analysis was carried out at a 0.05 significance level

As far as university differences were concerned (table 4), individuals at Erciyes University (M = 4.14, SD = 0.05) had more favorable attitudes than individuals at Ahi Evran University (M = 3.94, SD = 0.05) towards nuclear energy in the benefit dimension (*Wilks' l* = 1.73, $F(1, 214)$ = 8.25, p = 0.004, $\eta2$ = 0.04). Participants at Ahi Evran University (M = 3.48, SD = 0.05) appeared to express more favourable attitudes than individuals at Erciyes University (M = 3.20, SD = 0.04) in the risk dimension (*Wilks' l* = 3.27, $F(1, 214)$ = 19.45, p = 0.000, $\eta2$ = 0.09).

Table 4. Comparisons of Universities in terms of Dimensions

Dimension	University	M	SD
Benefit	Ahi Evran	3,94	0,05
	Erciyes	4,14	0,05
Risk	Ahi Evran	3,48	0,05
	Erciyes	3,20	0,04

DISCUSSION AND CONCLUSION

The purpose of this research was to investigate the views of PSTs who were enrolled in the department of science education about nuclear energy and test for differences in gender and university of instruction with respect to PSTs' views about nuclear energy.

According to the results, many of the participating PSTs believed that nuclear energy was beneficial. In particular, almost all participants were supportive of nuclear energy when it concerned electricity and

energy generation, national defense and prestige in the international community. This concurred with the research literature (e.g, Atila, 2004; Driver, Boyes, &Stanisstreet, 2010; Drottz-Sjoberg, & Sjoberg, 1991; Haşıloğlu, 2014; Kılınç et al., 2012; Komiya, Torii, Fujii, & Hayashizaki, 2008; Rosa & Dunlap, 1994). The reason these PSTs might have such favorable opinions could be a result of Turkey embarking on a quest for electricity and energy generation by nuclear power for the past several years. In the past in Turkey, crude oil, natural gas, coal, hydropower, and renewable energy sources have been used for electricity generation. It was widely acknowledged that Turkey's domestic energy resources were insufficient and even with all of the energy resources actively participating in energy production, Turkey was unable to overcome its shortage of energy. This had been the case since 1980 (Pamir, 2003). It was argued that nuclear energy might be the most effective way to address this energy shortage (Pagnamenta, 2009; Ulutaş, 2005). It was noted that the participating PSTs gave anxious and nervous responses toward Likert scale items on nuclear energy for issues relating to production of dangerous weapons, serious accidents, which would be occurring, and radioactive materials leakage. This was similar to previous studies concerning PSTs (e.g., Ateş & Saraçoğlu, 2013; Boyes & Stanisstreet, 1994; Haşıloğlu, 2014; Johnson, 1993; Kılınç et al., 2012; Sjoberg, 1999). Besides studies showed that PSTs thought that nuclear energy could cause disease in humans such as cancer (e.g., Ateş &Saraçoğlu, 2013; Kılınç et al., 2012).

The reasons that these PSTs had negative opinions on nuclear energy may be because of a lack of knowledge, skepticism, or distrust of the political, business and industry authorities. This is especially so for skepticism, which has a very important role in the formation of negative opinions and attitudes about environmental issues such as global warming and climate change (Corner, Whitmarsh, & Xenias, 2012; Hiğde, 2014; Hiğde & Öztekin, 2013; Islam, Barnes, & Toma, 2013; Poortinga, Spence, Whitmarsh, Capstick, & Pidgeon, 2011; Whitmarsh, 2005).

As stated, the PSTs who studied at Erciyes University supported nuclear energy more than the PSTs who studied at Ahi Evran University. Potential reasons that might explain these differences were:

(a) the facilities of each university. Although the 'Head Council of Education and Morality' directs that the same science education curriculum is used by Turkish universities, the university's physical, academic and social facilities as well as the quality of teaching staff may impact on PSTs' views.

(b) facilities of the cities in which the students dwell may vary PSTs' opinions. Each city has its own living conditions such as social life. For example, the city of Kayseri, home to Erciyes University, has a population

of almost 1 million, while Kırşehir, in which Ahi Evran University is situated, has 250,000 inhabitants (Turkish Statistical Institute, 2014). Accordingly, it may be that inhabitants, who live in a bigger city, may have more positive opinions about nuclear energy.

There are advantages of nuclear energy such as decreasing the necessity of energy imports, a country generating its own electricity, and having a greater voice in the international arena. There are also some disadvantages such as production of nuclear weapons and potential explosions or leakages occurring from nuclear power plants (such as has happened in Sellafield, England-1957, Kyshtym, Russia-1957, Chernobyl, Ukraine-1986, Tokaimur, Japan-1999, ("Greenpeace", 2009) and in Fukushima, Japan-2011.

The gender variable

Significant differences did not occur between the participating males and females. However, when the literature pertaining to the current topic was examined, this indicated that males held more positive views towards newer technologies than their female counterparts (Cutter, Tiefenbacher, & Solecki, 1992; Davidson &Freudenburg, 1996). In many of the studies, males were positive due to the economic and international prestige aspects of nuclear energy, while females focused on the negative impacts of nuclear energy on the environment and nature (e.g., Kenar, 2013; Kılınç et al., 2012; Özdemir & Çobanoğlu, 2008; Tekbıyık & İpek, 2008).

As a very limited number of researches are conducted (e.g.,Kılınç et al., 2012; Özdemir & Çobanoğlu, 2008), Turkish public' opinions are not measured precisely. Yet, because there is a possibility of building two nuclear power plants in the city of Mersin and Sinop, public opinion are of vital importance.

Further studies

It has been seen in many studies that there is a relationship between skepticism and both climate change and global warming (Corner, Whitmarsh, & Xenias, 2012; Hiğde, 2014; Hiğde & Öztekin, 2013; Islam, Barnes, & Toma, 2013; Poortinga, Spence, Whitmarsh, Capstick, & Pidgeon, 2011; Whitmarsh, 2005). It would be beneficial if future research investigates the relationships between these concepts and nuclear energy, especially as several studies have shown a relationship between nuclear energy and both climate change and global warming (International Atomic Energy Agency, 2013; Kılınç et al., 2012). Therefore, another area of future research could be in how individuals' skepticism toward nuclear energy predict their views in terms of climate change and global warming. One final suggestion for future studies is that studies could be about developing individuals' negative views toward nuclear energy with

longitudinal study. More comprehensive statistical measurements and methods can be used in new studies. For example, views toward nuclear energy may be examined in detail using qualitative research methods.

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