The effect of education on radiation risk perception of high school students

OYLUMLUOĞLU Emine Handan[1], and BÜKE Tayfun[2]

1. Muğla Menteşe Gazi Anadolu Lisesi, 48000-Muğla-Turkey (eminehandan@gmail.com)
2. Energy Systems Engineering Department, Muğla Sıtkı Koçman University, 48000-Muğla-Turkey (tbuke@mu.edu.tr)

Abstract: Radiation risk perception seems to be quite different because radiation is not well known issue by society. Therefore, preliminarily the case about radiation risk perception of society should be known and, as a result of education the changing of radiation risk perception should be determined. The aim of this study is to determine the level of radiation knowledge and the knowledge of radiation risk perception of young people who have a certain level of education and are easier to educate if they are educated about the topic and to correct the perception errors and the radio phobia effect on radiation risks in young people. For this purpose, a questionnaire consisting of 20 questions was prepared with help of the literature. In the studying process, this questionnaire was applied to 362 students in 11th grade class of Muğla Menteşe Fen Lisesi, Muğla Menteşe Öğretmen Anadolu Lisesi, Muğla Menteşe Anadolu Lisesi and Muğla Menteşe Gazi Anadolu Lisesi which are in Menteşe district of Muğla. As a result of this study, it has been demonstrated the importance of education in correcting perception errors of radiation risk.
Keyword: radiation; risk perception; acceptance; likert scale; questionnaire

1 Introduction

Nuclear power contributes to over 11% of the world's electricity supply [1]. As of December 2017, 448 nuclear power plants are operating and 59 nuclear power reactors are under construction in the worldwide [2].

Advanced designs have been developed for all types of reactors. The main goals of the designers and manufactures are: to improve the economics of nuclear power, reduce the residual risk of accident, reduce the emissions and residuals, including radioactive waste from the routine operation of nuclear facilities, expand the resource base and broaden the range of applicability of nuclear power [1, 3].

For many decades, like many developed countries, Turkey has controlled her electricity sector as a state-owned monopoly. However, faced with rapid electricity demand growth, Turkey started to consider nuclear option [4]. In 2010, the Turkish government signed a nuclear power plant construction agreement with a Russian company. The nuclear power system will operate 4x1200 MW at the Akkuyu district of Mersin. The Akkuyu Nuclear Power Plant currently under construction [5].

Social acceptance of the nuclear power is mainly depending on nuclear accidents [6] negative consequences for health and the environment [7,8] and also radiation risk perception[9-11]. Nuclear power generation is an important science and technology issues for which we see a problematic gap between experts and the general publication. And there are a lot of study for factors that influence public acceptance of nuclear power [12-21].

Kathleen *et al*. [12] are studied on one section of a risk perception survey given to two groups of individuals with a more specialized education (scientists and physicians) and laypeople (villagers) in the Semipalatinsk region of Kazakhstan.

According to Pidgeon *et al*. study [13], the higher proportions of the British public are prepared to accept nuclear power if they believe it contributes to climate change mitigation, this is a highly conditional view, with very few actively preferring this over renewable sources given the choice.

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In order to state, the differences in attitudes between nuclear power generation and other science and technologies and the relationship between students' interests in science and attitudes toward nuclear power generation are conducted an attitude survey among senior high school students[14].

Yangping *et al.* [15] are proposed a strategy for investigating public perception and acceptance in China, in a continuous and accurate way, and testing the effectiveness of public education in order to find a proper way to improve the perception and acceptance of nuclear energy in China. Questionnaires are conducted separately both before and after public education activities on nuclear energy held in Beijing. Chantharanuwong *et al*. [16] are aimed to explored the students' metacognition on nuclear energy topic of 219 secondary school students in the Northeast of Thailand with the Questionnaire of Metacognition on Nuclear Energy issues as five issues are nuclear reaction, transformation of nuclear energy, nuclear power plant, the radioactive, and nuclear energy atom for life, and 20 students' interview were employed for data collection.

He *et al*., [17] were investigated public trust towards nuclear policy and industry among Chinese citizens living close to nuclear facilities, and whether and how communication and information disclosure (can) play a role in mitigating lack of credibility and trust.

Han *et al*. [18] are designed as a communication strategy to form a wide social consensus on the use of radiation and nuclear power to improve public understanding. To provide the basic source data necessary for planning an educational-involvement strategy, radiation work study activities were conducted with elementary, middle, and high school students who were expected to show great educational ripple effects.

A questionnaire survey was conducted to investigate social acceptance issues of nuclear power from local residents' perspective in Shandong Province, China [20]. A causal model explaining Chinese university students' acceptance of nuclear power was tested. In their model, they hypothesized that perceived energy supply benefits, environmental benefits, and risks are determinants of Chinese university students' acceptance of nuclear power. They further assumed that trust affects perceived energy supply benefits, environmental benefits, and risk perception [21].

The radiation risk perception is an important factor for social acceptance of nuclear power. People exposed to radiation have demonstrated traumatic psychological effects from the unknown health impacts [22]. All of these factors may increase a person's negative perception of potential risk. On the other hand, Media and internet reports of environmental disasters contribute significantly to important changes in public opinions and behaviours toward the environment, and opposition to nuclear power [23].

It is important to examine an effective radiation risk perception training strategy for young people, which is easier to educate people about nuclear energy production to be acceptable to the public.

The aim of this study is to determine the level of radiation knowledge and the knowledge of radiation risk perception of young people who have a certain level of education and are easier to educate if they are educated about the topic and to correct the perception errors and the radio phobia effect on radiation risks in young people. For this purpose, a 5-point Likert scale [15, 19, 21, 24] questionnaire consisting of 20 questions was prepared with help of the literature [7, 12, 15, 25-27]. In the studying process, this questionnaire was applied to 362 of the 408 students in 11th grade class of Muğla Menteşe Fen Lisesi, Muğla Menteşe Öğretmen Anadolu Lisesi, Muğla Menteşe Anadolu Lisesi and Muğla Menteşe Gazi Anadolu Lisesi which are in Menteşe district of Muğla. Muğla province is one of the important touristic settlements of Turkey. Face to face questionnaires were applied separately before and after student education on radiation knowledge and the knowledge of radiation risk perception.

2 Methods

In the study, high school students were chosen as respondents. Because of the reason high school students were easier to educate on level of radiation knowledge and the knowledge of radiation risk perception. Firstly, a 5-point Likert scale questionnaire consisting of 20 questions was prepared with help of

the literature. Secondly this face to face questionnaires were applied separately before and after student education on radiation knowledge and the knowledge of radiation risk perception.

2.1 Questionnaire preparation and application

The survey questionnaire contained 20 questions were constructed to measure level of radiation knowledge and the knowledge of radiation risk perception.

The design of the questions was guided by the relevant survey and academic literature, but was also subject to extensive stakeholder consultation with individuals from a spectrum of opinion on the nuclear energy experts. Questions in the questionnaire were included on knowledge of radiation, health effects of radiation exposure, radiation risks and radiation effects of nuclear reactor accidents.

The above-mentioned questionnaire was initially applied to 40 students in 11th grade class of Muğla Menteşe Fen Lisesi, Muğla Menteşe Öğretmen Anadolu Lisesi, Muğla Menteşe Anadolu Lisesi and Muğla Menteşe Gazi Anadolu Lisesi which were in Menteşe district of Muğla on 15-18 September 2014 with a 25-question draft questionnaire. With the information obtained from the pre-test, the questions in the draft questionnaire were re-evaluated in terms of "response time", "intelligibility", "responsiveness", "suitability" and "consistency" and the final questionnaire was given as a result of the evaluations. The final questionnaire consists of 20 questions and it was presented in Table 1. A 5-point Likert scale (1=strongly disagree; 2=disagree; 3=no opinion; 4=agree; 5=strongly agree) was used to measure all items in the questionnaire.

The questionnaire given in Table 1 was applied to students in 11th grade class of Muğla Menteşe Fen Lisesi, Muğla Menteşe Öğretmen Anadolu Lisesi, Muğla Menteşe Anadolu Lisesi and Muğla Menteşe Gazi Anadolu Lisesi which are in Menteşe district of Muğla for the purpose to determine the level of radiation knowledge and the knowledge of radiation risk perception of young people who have a certain level of education and are easier to educate if they are educated about the topic and to correct the perception errors and the radio phobia effect on radiation risks in young people.

Table 1 Radiation risk perception questionnaire.

Questions	(1)	(2)	(3)	(4)	(5)
Q1-The effect of radiation decreases as it moves away from the radiation source.					
Q2-The people who lives at high altitudes exposed to natural radiation more than the people who lives at the sea level.					
Q3-The radiation dose received at a height of 10000 meters is higher than the dose of radiation received at ground level.					
Q4-We take radiation from everything we consume.					
Q5-An adult human is a 4000-6000 Bq radiation source.					
Q6-Among 100000 people who exposed to radiation which is 400 times more than natural amount, all of them will get cancer.					
Q7-A person who is exposed to 100 mSv radiation will have serious health problems because of this.					
Q8-Natural radioactive elements have caused natural radiation since the beginning of the Earth.					
Q9-The risk of radiation to cancer is higher than many known carcinogens.					
Q10-The hereditary effects of radiation on humans have not been proven.					
Q11-The probability of 1000 people dying in a plane crash is much greater than the probability of dying the same number in a country with 100 nuclear reactors.					
Q12-In the 1979, a large part of the USA population has exposed to radiation, due to the accident in Three Miles Island nuclear plant.					
Q13-A large part of the Turkey population has exposed to radiation, due to Three Miles Island nuclear reactor accident in USA.					
Q14-The cancer and genetic risks of the Chernobyl nuclear reactor accident of the Turkey society is less compared to cancer and					

genetic risks of the natural radiation.					
Q15-A large proportion of the cancer disease seen in people in the Eastern Black Sea is caused by the Chernobyl nuclear reactor accident.					
Q16-The radiation effect of the Chernobyl nuclear reactor accident occurred at the same level throughout the world.					
Q17-The radiation effects of the Fukushima nuclear reactor accident were at the same level in all of Japan.					
Q18-The radiation effects of the Fukushima nuclear reactor accident will also be seen in Turkey in the coming years.					
Q19-If nuclear reactors have a low risk of radiation, I would like them to be used for generating electricity.					
Q20-I am affected by all the knowledge I get from the information sources about radiation.					

High school education in Turkey includes 4 years. These years are graded as 9th, 10th, 11th and 12th classes. 11th grade students were preferred to 9th and 10th grade students in this study because they are more educated in terms of education. In addition, it was not possible for 12th grade students to participate in the study. Because of they were prepare for university exams.

Face to face questionnaires and education activities were applied to 362 of the 408 students in 11th grade class separately before and after student education on radiation knowledge and the knowledge of radiation risk perception in 15 October 2014, and ended in 15 December 2014. In the course of applying the questionnaire to the students before and after the training, the students were given a two-week gap with the purpose of conducting the research in the form of the knowledge of the information they received and the necessary visions.

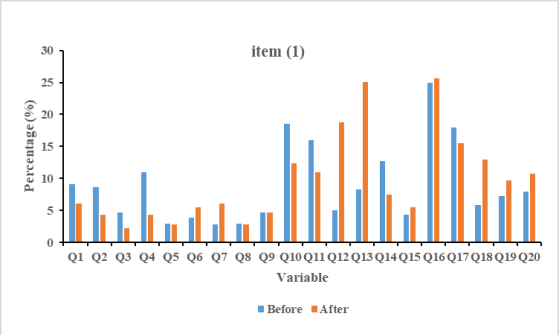
The education activities were consisted of face-to-face communication and explanation which introduces the basics of radiation knowledge, health effects of radiation exposure, radiation risks and radiation effects of nuclear reactor accidents. The content of the education activities was contained answers of the 20 questions in the questionnaire. The face-to-face education was conducted in one-to-one sessions, held by academician working in nuclear fields. All academicians were professors. The video (20 minutes) and PowerPoint materials (40 minutes) on the basics of radiation knowledge, health effects of radiation exposure, radiation risks and radiation effects of nuclear reactor accidents were used by academicians in education sessions. The education period was from 30 October 2014 to 30 November 2014.

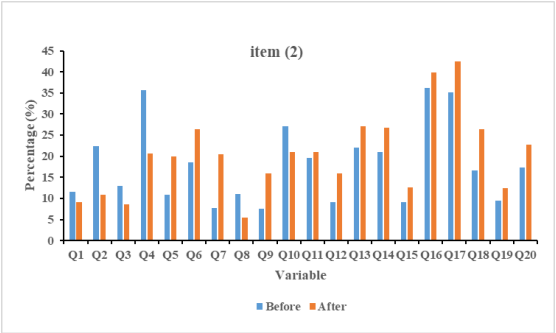
2.2 Data analysis

Data analysis was conducted in SPSS 20 software [28] using the following statistics: frequency percentages and mean. The Kolmogorov-Smirnov Test and Wilcoxon Test options of SPSS 20 software were also used for the post-activity tests.

3 Results and discussion

The frequency percentages of each question in the questionnaire and the average score of Likert index before and after the education are presented in Fig.1 and Fig.2 respectively. As can be seen from Fig.1 and Fig.2, It can be said that education can considered successful and the level of radiation knowledge and the risk perceptions of students have changed positive direction. When comparing the Likert index average scores for each question in the questionnaire before and after education. The ranking of the absolute change of Likert index average scores for each question in the questionnaire before and after education from higher value to lowest value are given as follow: Q2, Q4, Q12, Q3, Q10, Q13, Q8, Q18, Q9, Q7, Q6, Q20, Q1, Q11, Q15, Q14, Q19, Q17, Q5, Q16 (see Fig.1 and Fig.2).





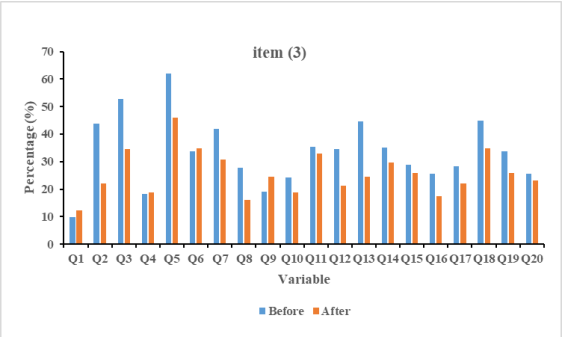


Fig.1. Frequency percentages of each item in the questionnaire before and after the education.

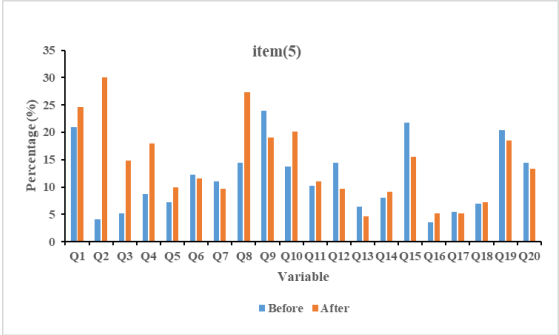


Fig.1. (Continue).

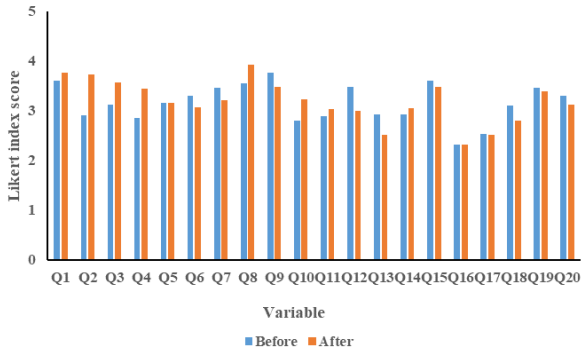


Fig.2. The average score of Likert index before and after the education.

The educational dependence of the data obtained in this survey was not obeyed normal distribution according to the Kolmogorov–Smirnov test[29]. Since the data was not obeyed normal distribution, the Wilcoxon test was applied to determine whether the all questions in the questionnaires were statistically significant or not[30]. The results of the Wilcoxon test are presented in Table 2. In Table 2, Z and p values are coefficient of Wilcoxon statistic and the significance of this value respectively.

As seen from Table 2, the questions Q2, Q3, Q4, Q6, Q7, Q8, Q9, Q10, Q12, Q13, Q18 and Q20 in the questionnaire were statistically significant difference between before and after education ($p < 0.05$) while Q1 Q5, Q11, Q14, Q15, Q16, Q17 and Q19 in the questionnaire were not statistically significant between before and after education ($p > 0.05$).

It can be stated that education is considered successful and the radiation risk perceptions of the students change positively for the questions Q2, Q3, Q4, Q6, Q7, Q8, Q9, Q10, Q12, Q13, Q18 and Q20 in the questionnaire.

Although, the questions Q1 Q5, Q11, Q14, Q15, Q16, Q17 and Q19 in the questionnaire were not statistically significant between before and after education. But the continues education of the students about radiation risk perception may be change their ideas positively about the radiation risk perceptions for the questions Q1 Q5, Q11, Q14, Q15, Q16, Q17 and Q19 in the questionnaire. Since the absolute change of Likert index average scores for those questions in the questionnaire before and after education in the positive direction.

Table 2 Wilcoxon test results.

Variable	Before education	After education	Z	p
Q1	3,60	3,76	-1,758	0,079
Q2	**2,90**	**3,73**	**-9,314**	**0,000**
Q3	**3,12**	**3,57**	**-6,258**	**0,000**
Q4	**2,86**	**3,44**	**-6,402**	**0,000**
Q5	3,15	3,16	-0,078	0,938
Q6	**3,30**	**3,07**	**-2,857**	**0,004**
Q7	**3,45**	**3,20**	**-3,475**	**0,001**
Q8	**3,55**	**3,92**	**-4,986**	**0,000**
Q9	**3,76**	**3,48**	**-3,355**	**0,001**
Q10	**2,80**	**3,22**	**-4,375**	**0,000**
Q11	2,88	3,03	-1,786	0,074
Q12	**3,47**	**3,00**	**-5,081**	**0,000**
Q13	**2,93**	**2,51**	**-4,882**	**0,000**
Q14	2,93	3,04	-1,283	0,199
Q15	3,61	3,48	-1,652	0,099
Q16	2,31	2,31	-0,099	0,921
Q17	2,53	2,52	-0,179	0,858
Q18	**3,11**	**2,80**	**-3,718**	**0,000**
Q19	3,46	3,39	-1,111	0,267
Q20	**3,30**	**3,12**	**-1,987**	**0,047**

3.1 Limitations and future research

There are some limitations in the present study. Firstly, the present study did not include all people about radiation risk perception. Future research should consider more ingredients such as personal norms, the factors that affect the trust level and relevant knowledge about radiation.

Secondly, Turkey high school students were selected as respondents. Thus, 362 final samples may be not enough to investigate high school students' radiation risk perception of the whole country. Future researchers should choose larger representative respondents.

Finally, the present study was only focused on Turkey high school students' radiation risk perception.

4 Conclusions

The differences in radiation risk perception have been addressed by many studies conducted at the international level[11,12] with the thought that the radiation risk perception could be replaced by trainings to be given to all sections of the society. Since radiation is not a well-known subject in the society, it is seen that there are considerable differences in radiation risk perception. For this reason, it should be known at first that the society is primarily concerned with the radiation risk perception, and it should be determined whether the radiation risk perception changes as a result of the training.

The aim of this study is to determine the level of radiation knowledge and the knowledge of radiation risk perception of young people who have a certain level of education and are easier to educate if they are educated about the topic and to correct the perception errors and the radio phobia effect on radiation risks in young people.

As a result of this study, it has been demonstrated the importance of education in correcting perception errors of radiation risk.

The concepts of radiation risk and dread are more often expressed by people who oppose the nuclear power plants than by people who are in favour of nuclear power plants. Social mobilisation, and associated social amplification of risk perceptions, typically depends upon a several factors like interest group attention, media reporting, the influence of fundamental cultural values, even the onset of events over and above baseline attitudes towards the issue. Policy makers in the Turkey should be fully aware of both the fragmented, and the potentially transitory nature of such public concerns.

Turkey is in the process of transition to nuclear energy within a high percent for electricity generation. The 5000 MW Akkuyu reactor project is underway and Sinop and Kırklareli projects are being prepared at the same strengths. The greatest resistance to nuclear reactors by the community is realized with radiation concerns.

Based on the results of this study, radiation training should be emphasized. For this purpose, school curricula should be rearranged to give radiation information. More than face-to-face communication and education brochure, a web-based survey and education strategy should be developed for Internet respondents, and relevant analysis programs should be developed and coupled with the survey and education strategy.

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