International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Investigating Pre-service Primary School Teachers' Awareness Regarding Nuclear Energy as a Socio-scientific Issue

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Abstract

Pre-service teachers' awareness of nuclear energy as a socio-scientific issue is critical to understanding how future educators perceive and communicate complex scientific issues. Investigating the awareness of pre-service primary school teachers, who are expected to be more conscious about nuclear energy, to be able to think and discuss about the possible consequences and to provide accurate information to their future students, will help to reveal their current thoughts and knowledge. The aim of the study is to investigate the awareness of pre-service primary school teachers about nuclear energy and nuclear power plants. In this study, a survey method was adopted. Easily accessible sampling method was used to determine the study group. The study group consisted of 112 pre-service primary school teachers studying at the faculty of education of a university in the Eastern Black Sea Region of Turkey. The data of the study were collected through an unstructured interview form, analyzed by content analysis and presented as frequencies and percentages. It was observed that 55.4% of the pre-service primary school teachers' explanations about the concept of nuclear energy were in the category of partially scientific explanation and 59.8% of the pre-service primary school teachers did not favor the establishment of a nuclear power plant. In all grade levels, it was determined that female pre-service teachers who did not want the establishment of nuclear power plants were more than male pre-service teachers. It was determined that female pre-service teachers mentioned the harm dimension of nuclear energy more than male pre-service teachers on the basis of both gender and class. It was observed that 4th grade pre-service teachers made more positive explanations about the establishment of nuclear power plants compared to other grades. The pre-service teachers mostly focused on the environmental damage caused by nuclear energy and stated that the most fundamental issue is radiation. It was observed that they made statements that in case of an explosion in a nuclear power plant due to an earthquake or another reason, radiation would be released and that it was not easy to dispose of radioactive waste. In this case, it is important to provide the necessary information about the durability of nuclear power plants and how nuclear waste will be stored.

Keywords: Socio-scientific issue, Nuclear energy, Pre-service primary school teachers.

1. Introduction

The rapid growth of the world's population, industrialization, technological development, environmental issues and the depletion of fossil fuels are causing the demand for energy resources to increase, and meeting the demand for energy is a major issue on the world's agenda. It is argued that the world is suffering

from energy shortages and is looking for resources, that countries will face a major energy crisis in the near future if other energy resources cannot be provided, and that nuclear energy should be used for this purpose (Özdemir, 2014). Especially with the oil crisis in the 1970s, the oil-based energy industry lost its stability and reliability and the interest in nuclear energy reached the highest level (Eş et al., 2016). The energy crisis that emerged after the Russia-Ukraine war also forced countries to turn to alternative energy sources that can efficiently meet their energy needs (Arı & Yılmaz, 2023). Therefore, nuclear energy is seen as an alternative and important source in the increasing energy demand (Jho et al., 2014). However, although alternative energy is a fundamental factor in the development of the energy sector, the extent to which nuclear energy is reliable for the world is still a controversial issue (Karaeva et al., 2019).

Considering the increasing energy consumption due to industrialisation, technological development and population growth, the inadequacy of energy resources and the country's economy, Turkey has considered nuclear energy as an alternative option to meet its energy needs. Although there are some reservations against nuclear energy, the large energy deficit and dependence on foreign energy have made it necessary to turn to this source (Tümertekin & Özgüç, 2015). Nuclear energy is a resource that can meet high energy needs at low cost (Özdemir & Çobanoğlu, 2008). Nuclear power plants stand out compared to other alternatives due to the need for a safe, competitive, sustainable and accessible energy source that takes into account the environment, society and future generations (Republic of Turkey Ministry of Energy and Natural Resources, 2024). Nuclear power plants are becoming an important choice as they produce a lot of energy with a small amount of raw materials.

While nuclear power plants are an important source of electricity, they also raise a number of social, environmental and health concerns. The Chernobyl nuclear accident in 1986 and the explosions at the Fukushima nuclear power plant in Japan in 2011 continue to make nuclear energy the most controversial source of energy. Concerns about nuclear energy, especially the long-term storage of radioactive waste and the possible consequences of accidents, as well as the environmental and safety impacts of nuclear power plants, occupy the agenda of politicians and the public (van der Zwaan, 2008; Hakkıoğlu Tüylüoğlu & Türkan, 2023). The negative environmental and human health impacts of incidents at nuclear power plants can lead to safety concerns and negative perceptions in society. In Turkey, which is located in an earthquake zone, the possibility of a disaster similar to the Chernobyl and Fukushima disasters at the Akkuyu nuclear power plant, which is the country's first nuclear power plant and has not yet started producing energy, is on the mind. On the other hand, proponents of nuclear energy advocate nuclear energy as a solution to various environmental problems due to its low carbon emissions, while opponents oppose nuclear energy due to the risks of nuclear accidents, nuclear proliferation, improper radioactive waste management, and the high operating costs of nuclear power plants (Ho et al., 2018). Societal dilemmas about nuclear energy are often polarised, reflecting support for its potential benefits and fear of its risks. This polarisation requires individuals to be equipped to navigate these debates and promote informed decision making, while accepting different perspectives.

The literature suggests that individuals' attitudes towards nuclear energy and nuclear power plants are influenced by many factors, which in turn affect their acceptance or rejection of nuclear energy. Studies emphasise the influence of gender, education level, expectations, values, beliefs, risk perception, benefits and trust, as well as the level of nuclear knowledge of individuals on their acceptance or rejection of nuclear energy (van der Pligt, 1982; Stern et al, 1993; Stern et al, 1999; Whitfield et al., 2009; Palabıyık et al, 2010; Visschers et al, 2011; Corner et al, 2011; Wallquist et al., 2012; de Groot et al, 2013). Kapıcı and İlhan (2016) emphasise that pre-service teachers have different attitudes towards nuclear power plants,

which reflect a broader societal ambivalence towards social science issues. Their views on nuclear energy are often linked to their understanding of the impact of this energy on society and the environment. This suggests that pre-service teachers' views are not formed in isolation, but are influenced by their educational background and societal discourses about nuclear energy. This explains the impact of nuclear events such as the Fukushima disaster in shaping attitudes towards nuclear energy.

Some studies suggest that knowledge and attitudes towards nuclear energy improve with educational attainment and that educational interventions have an impact on attitudes towards nuclear energy. Niankara and Adkins (2020) found that younger students were less familiar with nuclear energy concepts than their older peers. Mahler and Barber (2013) found that younger university students were more likely to view nuclear energy as a critical issue than older university students. Similarly, Zhang et al. (2013) found that university students had a more detailed understanding of nuclear energy safety than high school students, highlighting that as students progress in their education, exposure to scientific concepts and critical thinking skills improve their ability to assess the risks and benefits of nuclear energy. Karaeva et al. (2019) highlighted that high school students who received comprehensive education on nuclear energy and its environmental impacts tended to have more positive attitudes. This suggests that educational curricula that include nuclear energy topics can positively influence students' perceptions and attitudes. On the other hand, there are studies suggesting that education level affects knowledge but may not significantly change attitudes, and that gender and social events such as the Fukushima disaster have an impact on the acceptance of nuclear energy. Akçay and Şavklıyıldız (2023) found that there was no significant difference between the attitudes of higher education students towards nuclear power plants according to their level of education and age, and that male higher education students had more positive attitudes. Yu et al. (2012) found that although educational level affects acceptance of nuclear power, gender differences persist, with female generally having more negative attitudes. Mahler and Barber (2013) found that female students were more likely than males to see nuclear energy as a serious environmental problem, both at the beginning and at the end of an environmental science course. Crettaz von Roten et al. (2016), analysing attitudes towards nuclear energy after Fukushima, found that younger students were more concerned about nuclear safety than older students. Bhanthumnavin and Bhanthumnavin (2014) suggest that after the Fukushima nuclear disaster, many countries became more reluctant to use nuclear energy.

Nuclear energy and reactors are socio-scientific issues that need to be evaluated in terms of sustainable living and environmental awareness (Ayaz et al., 2016). Socio-scientific issues are social dilemmas of relative health, environment and techno-scientific innovations that arise as a result of the complex interactions between science and society (Kolstø, 2001; Zeidler et al., 2002) and where individuals have to make a choice (Molinatti et al., 2010). In order for individuals to develop sustainable lifestyles and environmental awareness, it is important for them to be able to follow developments in science, technology, social, cultural, political and economic fields in the world in the current century and to use science and technology consciously. Individuals in the 21st century are expected to be aware of socio-scientific issues, to participate in decision-making processes, and to be willing to take action to protect the world in which they live and to find solutions to problems (Choi et al., 2011). In this case, it is necessary to have sufficient knowledge and awareness of socio-scientific issues in order to be able to understand and discuss situations and events related to socio-scientific issues and to actively create solutions to problems. Individuals who are aware of socio-scientific issues can play an effective role in making decisions that affect the fate of the country with a sense of responsibility towards society.

Furthermore, it is emphasised that socio-scientific situations should be included in the learning and teaching process in science education (Hurd, 1998; Zeidler & Keefer, 2003; Sadler, 2004; Zeidler et al., 2005; Walker & Zeidler, 2007; Hofstein et al., 2011; Lee et al., 2012). Zengin et al. (2012) emphasise that discussion environments related to socio-scientific issues should be presented to primary school students during science education in order for them to become more responsible individuals towards the environment in which they live. While discussing the nature of socio-scientific issues in students' classroom environments, Kılınç et al. (2017) emphasised the need for teachers to have a good understanding of the dimensions and scope of socio-scientific issues in order to help students achieve appropriate learning goals. Therefore, it is expected that pre-service teachers, who are known to have an impact on their students' future awareness of socio-scientific issues, will themselves be aware of and have sufficient knowledge of socio-scientific issues. In this context, the aim of this study was to determine the awareness of pre-service primary school teachers of the socio-scientific issue of nuclear energy. This study seeks to answer the following questions:

1. How do primary school pre-service teachers' levels of explanation about nuclear energy differ by gender and grade?
2. How do primary school pre-service teachers' explanations of the effects of nuclear energy differ by gender and grade?
3. How do primary pre-service teachers' explanations of why nuclear power should or should not be built differ according to gender and grade?

2. Methodology

The study was conducted using the survey method. As the data for the study were collected at a single point in time, the cross-sectional survey model was preferred. The cross-sectional survey method aims to describe the event or group that is the subject of the study without any intervention, change or influence and provides the opportunity to obtain information from a group consisting of a large number of individuals at one time (Büyüköztürk et al., 2015; Creswell, 2017).

2.1. Study Group

The easily accessible sampling method, which is one of the purposive sampling methods, was used to determine the study group. This sampling method is preferred in terms of practicality and time saving and ensures the maximum utilisation of the resources used in the research process (Büyüköztürk et al., 2015). The study group consisted of 112 volunteer pre-service primary school teachers, studying at different grade levels in the Faculty of Education of a university in the Eastern Black Sea region of Turkey. The demographic characteristics of the pre-service teachers who formed the study group are presented in Table 1.

Table 1. Demographic characteristics of the pre-service teachers

Gender	Grade Level								Total	
	1st grade		2nd grade		3rd grade		4th grade			
	f	%	f	%	f	%	f	%	f	%
Male	10	8,93	11	9,82	10	8,93	7	6,25	38	33,93
Female	23	20,54	19	16,96	21	18,75	11	9,82	74	66,07
Total	33	29,47	30	26,78	31	27,68	18	16,07	112	100

It consists of 66.1% female and 33.9% male pre-service teachers in the study group. The study group consists of 29.4% in the 1st grade, 26.7% in the 2nd grade, 27.8% in the 3rd grade and 16.1% in the 4th grade.

2.2. Data Collection

The data for the study were collected using an unstructured interview form consisting of nine open-ended questions. The main reason for choosing open-ended questions is to allow individuals to express their perceptions of the given situations in their own words. The questions in the data collection instrument are listed below:

1. What is nuclear energy?
2. What is the role of nuclear energy in world energy production? How much of the world's energy is provided by nuclear power plants?
3. How is nuclear energy produced?
4. What are the uses of nuclear energy?
5. What do you think about the benefits of nuclear energy?
6. What do you think about the disadvantages of nuclear energy?
7. What do you think about the Akkuyu nuclear power plant, Turkey's first nuclear power plant, which is not yet operational?
8. How much of Turkey's energy needs do you think the Akkuyu nuclear power plant will meet?

For the questions in the data collection tool, the opinions of two experts specialised in the field of science were sought, one with studies on social science issues and the other with studies on renewable energy sources. Before the final version of the data collection tool was used, a pilot study was conducted with eight university students to test the appropriateness of the questions in the data collection tool at the student level.

2.3. Data Analysis

The study is a qualitative study and the data were analysed using content analysis. Content analysis is identified as a systematic, methodological and objective method used to identify, classify and interpret the basic components in the text content and is carried out to analyse the existence of categories/codes systematically determined in a text or visual (Robert & Bouillaget, 1997). In qualitative research, data are analysed as coding the data, finding themes, organising and describing the data according to codes and themes, and interpreting the findings in four stages (Yıldırım & Şimşek, 2011). The data obtained through content analysis are presented as frequency tables.

The pre-service teachers' explanation levels were categorised as scientific explanation, partly scientific explanation and unscientific explanation, as shown in Table 2. There are studies in the literature that use such categories in the analysis of open-ended questions (Abraham et al., 1992; Abraham & Williamson, 1994). Table 2 shows the categories and example sentences for each category.

Table 2. Evaluation Criteria

Categories	Criteria	Example sentences
Scientific Explanation	Explanations (using scientific language) about the energy	Nuclear energy is a type of energy derived from the nucleus of the atom and is a very large amount of energy resulting from the splitting of the nucleus into

	released during the fission of nuclear materials or the principle of operation of power plants	two parts (fission) by a neutron hitting the nucleus of a heavy radioactive element such as uranium and plutonium found in nature or artificially produced, or the fusion of light radioactive element atomic nuclei into a heavier nucleus (fusion) (Turkish Energy, Nuclear and Mineral Research Agency, 2024).
Partly Scientific Explanation	Explanations such as obtaining energy from nuclear material, producing energy from atoms (incomplete explanation of how it is produced using scientific language)	It is an energy source with high potency and/or efficiency obtained by splitting the atomic nucleus.
Unscientific Explanation	Lack of a scientific explanation, completely wrong explanation or use of incorrect examples	It is an inexhaustible source of energy obtained chemically from fossil fuels.

In the analysis phase of the pre-service teachers' explanations on nuclear energy, the data obtained were analysed and categorised independently by the researcher and an expert specialised in the field of science. The researcher and the expert came together and compared the analyses carried out separately and made the necessary adjustments by reaching a consensus on the differences in the analyses. The agreement value between the researcher and the expert was calculated using Miles and Huberman's (1994) formula [reliability = agreement/(agreement + disagreement)] and this value was reported as 0.87. In order to increase the validity of the study, representative excerpts are also presented for each determined category (Yıldırım & Şimşek, 2011).

3. Findings

3.1. Findings on Pre-Service Teachers' Explanation Levels about Nuclear Energy

First, the pre-service teachers' explanations of what nuclear energy is, its role in energy production, how it is produced, its effects and its uses are categorised and shown with their frequencies in Table 3. Then, these explanations of the pre-service teachers were analysed according to the evaluation criteria shown in Table 2 and classified into the categories of scientific explanation, partly scientific explanation and unscientific explanation.

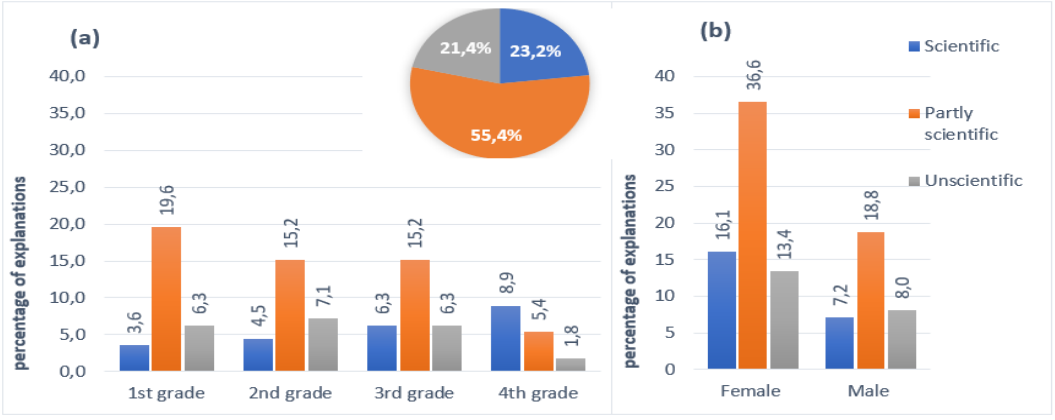
Table 3. The pre-service teachers' explanations about the nuclear energy

Categories	Codes	f	Categories	Codes	f
Energy Source	Source with strong/large impact	47	Mass-energy	Conversion of mass to energy	7
	High efficiency welding	39	Fossil fuels*	Underground resources	3
	Cheap/profitable energy source	6		Various minerals	1
	The most important source	5		Petroleum products	1
	Reliable source	5		Fossil fuel	1

	Alternative energy source	4	Renewable*	Continuous	4
Derived from radioactive material	Uranium	24		Inexhaustible	2
	Thorium	11		Sourced from nature	2
	Radioactive element	4		Derived from natural resources	2
	Radioactive material	3		Elements in nature	1
	Nuclear matter	1	How it was obtained*	Produced by chemical reaction	14
Nuclear reaction	The nucleus of an atom	18		Cannot be produced naturally	5
	The fission of the atom	16		With the cooling power of water	2
	Nuclear produced in NPP	2		Using various gases	2
	With Fission and Fusion	2		Artificially produced	1
	Breakdown of some heavy elements	1		As a result of reaction with substances such as cyanide	1
Usage area	Meeting energy needs	19		By melting materials such as nickel and boron at high temperature	1
	Electricity generation	16			
	Nuclear weapons	6	* In the unscientific explanation category		
	Defense industry	4			
	Warming up	3			

The distribution of pre-service teachers' level of explanation of the concept of nuclear energy by gender and grade is shown in Figure 1.

Figure 1. The distribution of the level of explanation of nuclear energy by gender and grade



It can be seen that 23.2% of the pre-service teachers' explanations belong to the category of scientific explanations, 8.9% belong to the 4th grade, 6.3% to the 3rd grade, 4.5% to the 2nd grade and 3.6% to the 1st grade. Of the pre-service teachers who made scientific explanations, 16.1% were female and 7.2% were male. The scientific explanations of the pre-service teachers consist of the statements in the

categories of 'obtained from radioactive material, produced by nuclear reaction and mass-energy conversion' shown in Table 3. Some examples of scientific explanations are given below.

"It is a highly efficient form of energy produced from radioactive materials such as uranium and thorium through fission and fusion reactions and used to generate electrical energy." P18 (Nuclear reaction, derived from radioactive material, usage area, energy source)

"It is the energy obtained from radioactive elements as a result of nuclear reaction. It is obtained by splitting heavy elements such as uranium in nuclear reactors. Nuclear energy was discovered in 1986 by the French physicist Henri Becquerel with the discovery of X-rays." P35 (Derived from radioactive material, nuclear reaction)

"Nuclear energy is the large amount of energy resulting from the splitting of atomic nuclei. This energy is converted into electrical energy in nuclear reactors and used for various industrial and domestic purposes." P57 (Nuclear reaction, usage area, energy source)

55.4% of the pre-service teachers' explanations are in the category of partially scientific explanations, 19.6% were in the 1st grade, 15.2% were in the 2nd grade, 15.2% were in the 3rd grade and 5.4% were in the 4th grade. Of the pre-service teachers who gave partially scientific explanations, 36.6% were female and 18.8% were male. The partially scientific explanations of pre-service teachers regarding the concept of nuclear energy consist of statements in the categories of 'energy source, area of use and obtained from radioactive material' shown in Table 3. Some examples of the partly scientific explanations are given below.

"*It is a powerful energy obtained by nuclear means from elements such as uranium and thorium." P29 (Energy source derived from radioactive material)*

"It is a highly efficient radioactive material source. It meets our energy needs." P47 (Energy source derived from radioactive material)

"It is an alternative energy source. We have the source used in nuclear energy and we can process it and produce our own energy." P86 (Energy source)

"Nuclear energy is made from radioactive elements and a lot of energy is released, it is cheap energy." P90 (Energy source)

21.4% of the pre-service teachers' explanations were in the category of unscientific explanations, 7.1% were in 2nd grade, 6.3% were in 1st grade, 6.3% were in 3rd grade and 1.8% were in 4th grade. Of the pre-service teachers who gave unscientific explanations, 13.4% were female and 8.0% were male. The unscientific explanations of the pre-service teachers regarding the concept of nuclear energy consist of the statements in the categories of 'fossil fuels, renewable and how it is obtained' shown in Table 3. Some examples of the unscientific explanations are given below.

"*As nuclear energy uses different gases, I think it has a harmful effect on the environment." P17 (How it is produced)*

"Nuclear energy is a technology that uses petroleum products as raw materials and concentrates the energy using technological means." P50 (Fossil fuels)

"Nuclear energy is a type of energy produced by specialised people using scientific means for various purposes, which has economic-strategic-scientific features, where the power factor is kept in the foreground and armament is generally kept in the foreground. Nuclear energy is inexhaustible. Most energy can be obtained from nuclear power." P52 (Renewable, usage area)

3.2. Findings Related to Pre-Service Teachers' Explanations about The Effects of Nuclear Energy

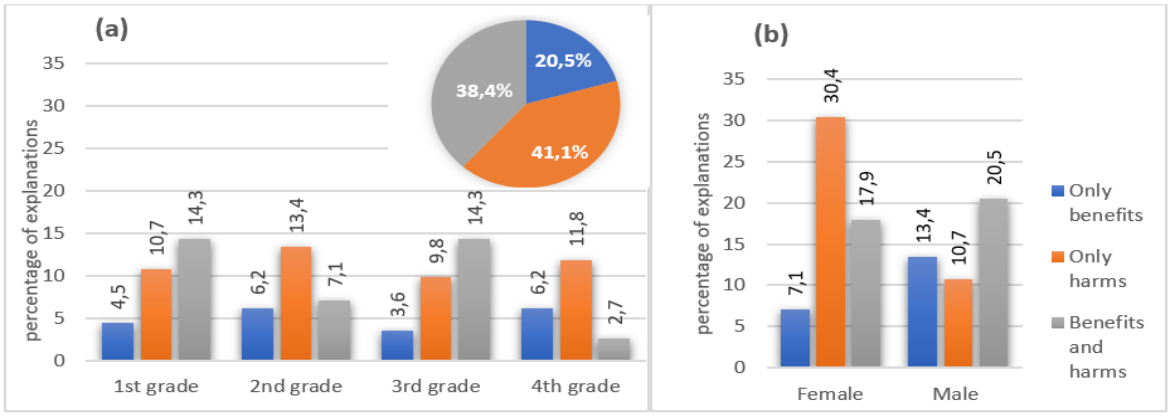
First, the pre-service teachers' explanations of the effects of nuclear energy are categorised and presented with their frequencies in Table 4. Then, the distribution of pre-service teachers' explanations of the effects of nuclear energy according to gender and grade level is shown in Figure 2.

Table 4. The effects of nuclear energy according to pre-service teachers

Category	Codes	f	Category	Codes	f
Economic	Economic development	35	Environmental*	Environmental pollution	24
	Meeting energy needs	29		Harm to nature	17
	Energy efficiency	21		Biodiversity decreases	14
	Cheap energy/electricity	12		Disruption of natural balance	9
	Electricity generation	11		Affects climate	7
	Job creation/employment growth	6		Air pollution	3
	Warming up	3		Water pollution	3
	Industrial progress	3		Impact on agriculture	3
	Indicator of sophistication	2		Atmosphere is damaged	2
Politics	Reduction/elimination of external dependency	24		Reducing fossil fuels	2
	Defense / Military area	10		Biological balance is disturbed	1
	Power	8	Harm to human life*	Damage	41
	Strategic importance	3		Permanent damage	21
	War*	5		Cancer	16
	Arms industry*	4		Death	10
Science and Technology	Nuclear weapons production	21		Mental retardation	2
	Technological development	5		Decrease in species	2
	Clean/safe environment	2		Genetic problem	2
Risk from nuclear power plants*	Radiation	30		Shortening life expectancy	1
	Explosion	11	* Negative statements about the impact of nuclear energy		
	Nuclear waste/radioactive material	10			
	Leakage	7			
	Harmful gases from the power plant chimney	2			

The distribution of pre-service teachers' explanations of the effects of nuclear energy by gender and grade is shown in Figure 2.

Figure 2. The distribution of explanations about the effects of nuclear energy by gender and grade level



When analysing Figure 2, 20.5% of the pre-service teachers mentioned only the benefit dimension of nuclear energy, 6.2% were in the 2nd class, 6.2% in the 4th class, 4.5% in the 1st class and 3.6% in the 3rd class. Of the pre-service teachers who mentioned only the benefit dimension of nuclear energy, 13.4% were male and 7.1% were female. 41.1% of the pre-service teachers mentioned only the harm dimension of nuclear energy, 13.4% were in the 2nd grade, 11.8% in the 4th grade, 10.7% in the 1st grade and 9.8% in the 3rd grade. Of the pre-service teachers who mentioned only the harm dimension of nuclear energy, 30.4% were female and 10.7% were male. It is seen that female pre-service teachers in all grade levels mentioned the harm of nuclear energy more. 38.4% of the pre-service teachers mentioned both the benefit and the harm dimensions of nuclear energy, 14.3% of them in the 1st grade, 14.3% in the 3rd grade, 7.1% in the 2nd grade and 2.7% in the 4th grade. Of the pre-service teachers who mentioned both the benefit and harm dimensions of nuclear energy, 20.5% were male and 17.9% were female.

As shown in Table 4, the pre-service teachers' positive statements about nuclear energy in the 'economic' category were as follows: nuclear energy will provide economic development, meet energy needs, produce large amounts of energy and electricity cheaply, and be more efficient than other types of energy. It was observed that under the 'political' category, pre-service teachers stated that it will reduce external dependency, contribute to power and defence, and under the 'science and technology' category that it will lead to the production of nuclear weapons and technological developments. While pre-service teachers who made positive statements about the impact of nuclear energy tended to make economic and political statements, their environmental statements were limited. Some examples of positive statements about nuclear energy are given below.

"Nuclear energy means more weapons. Nuclear energy plays a major role in the wars in the world today. If you have money, weapons, technology and nuclear power, I think there is no country you cannot dominate." P40

"One of the greatest advantages of nuclear energy is that it is an energy source that does not depend on fossil fuels. However, the use of nuclear energy brings with it serious security risks and the problem of nuclear waste." P62

"It provides much more energy production from a small amount of material and foreign dependency is greatly reduced. As we can provide our own electricity production, it will also provide employment opportunities." P75

"Nuclear energy causes less damage to the environment and is highly efficient. It has an important role to play in meeting energy needs as it has the capacity to generate large amounts of electricity." P103

As can be seen in Table 4, the negative statements made by the pre-service teachers regarding the effects of nuclear energy were as follows: in the category 'harm to human life', it will cause permanent damage, cancer and death, and in the category 'environment', it was stated that biodiversity will decrease and the natural balance will be disturbed due to environmental pollution and damage to nature. In addition, it can be seen that the views on radiation, explosion and nuclear waste dominate the negative statements made by the pre-service teachers. Some examples of negative statements about nuclear energy are given below.

"Nuclear power means radiation. If it is not controlled by people with sufficient knowledge, it will give people cancer." P27

"It is energy obtained from radioactive material. It is good that it has been established in Turkey and it gives life to the economy, but it is quite funny that we are opening these plants when the world is trying to close them." P34

"Electricity is produced by nuclear power. I am a firm believer in its economic benefits, but I do not think that the people who will operate the power plants will show the necessary sensitivity. Because I know that the people of the Black Sea have been affected by such an accident before, and because I am a Black Sea person myself, many people in my family have died of thyroid cancer. Even if the possibility of an accident is very small, I believe that nothing is more precious than human life." P105

3.3. Findings on Pre-Service Teachers' Explanations Justifications on Whether Nuclear Power Plants Should Be Established or Not

Pre-service primary school teachers' justifications on whether nuclear power plants should be established or not are given in Table 6.

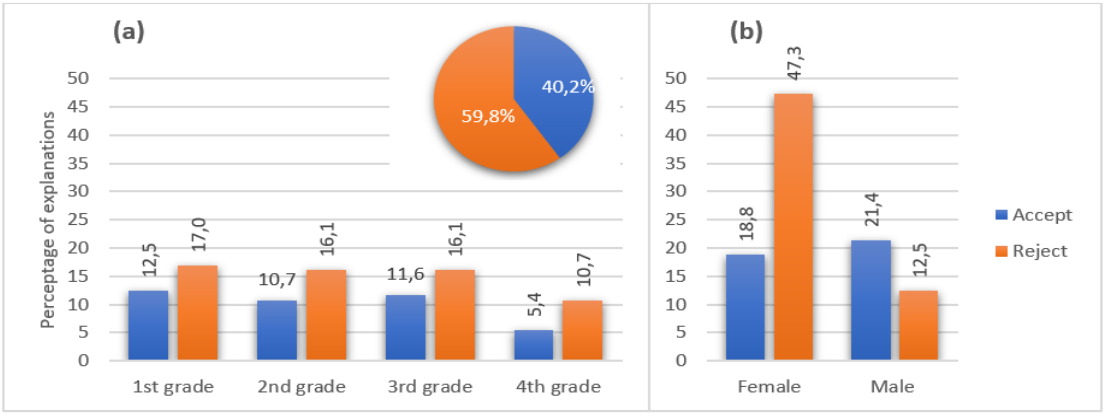
Table 6. The justifications of the participants on whether nuclear power plants should be established or not

Categories	Codes	f	Categories	Codes	f
Harm to living beings	Cancer	17	Environmental damage	Harm to nature	8
	Death / The end of humanity	15		Global warming	8
	Permanent damage	12		Water pollution	3
	Decrease in species	4		Soil pollution	3
	Various diseases/injuries	3		Air pollution	3
Anthropogenic risk	Inexperience	13	Risk from power plant	Explosion	45
	Insufficient information	6		Radiation	33
	Psychological/ unpreparedness	2		Leakage	29
	Carelessness/negligence	2	Natural disasters	Earthquake	16
Technology-driven inadequacy	Insufficient infrastructure	10		Volcanic eruption	1
	Technological inadequacy	10	Political	Nuclear weapons/war	17
	Security	2		Insufficient financial resources	5
	Meeting energy needs	17	Recommend*	In places where no one lives	29

Economic benefit*	Raw material availability	11		Storage and disposal of waste	24
	Excess energy/efficiency	9		Control/work by engineers with sufficient knowledge	20
	Cheap electricity	2		Informing the public	9
	Contribution to the economy	2		Bringing engineers from abroad	6
Future role*	Enables development	15		Insufficient raw materials	5
	Power indicator	8		Utilisation of renewable resources	3
	Reduced need for other resources	3	*Positive statements in favour of the establishment of nuclear power plants		
	Weapons production	2			

The distribution of pre-service teachers' explanations on whether nuclear power plants should be established or not according to gender and grade level is given in Figure 3.

Figure 3. The distribution of explanations on whether nuclear power plants should be established or not according to gender and grade level



As can be seen in Figure 3, 59.8% of the pre-service teachers who did not want the establishment of nuclear power plants were 17% in the 1st grade, 16.1% in the 2nd grade, 16.1% in the 3rd grade and 10.7% in the 4th grade. Of the pre-service teachers who did not want nuclear power stations to be built, 47.3% were female and 12.5% were male. As seen in Table 6, the justifications of the pre-service teachers who stated that nuclear power plants should not be established were evaluated under the categories of 'harm to living beings, environmental damage, technology-induced risk, anthropogenic risk, risk from power plant, natural disasters, technology- driven inadequacy, political and financially deficiency'. The pre-service teachers stated that Turkey does not have sufficient technological infrastructure and therefore it will cause security problems, financial resources are not sufficient, it will harm nature, cause environmental pollution and global warming. Below are some excerpts from the statements of the pre-service teachers about not establishing a nuclear power plant.

"It is a powerful energy. When there is an explosion, there is a lot of damage to the environment. It causes many human casualties. For example, in the Chernobyl disaster in Japan, many people lost their lives and

the damage to the natural environment was great. In the event of an explosion at the power plant in Mersin in Turkey, the Mediterranean, South East and Central Anatolia would be under threat. It is extremely harmful to human health." P24

"I think Turkey is not ready for nuclear energy both technically and financially. When we look at the countries that have nuclear energy, they have advanced technology. Moreover, a nuclear accident could have bad consequences." P91

"Nuclear power releases a lot of energy. Japan is completely an earthquake zone. It would have been a disaster if the nuclear power plant had exploded, but the Japanese sensitivity to earthquakes prevented this. In Turkey, there is no sensitivity to earthquakes. Although we are a country where earthquakes are active, earthquake-resistant constructions are not built." P112

40,2% of the pre-service teachers who favoured the establishment of nuclear power plants, 12,5% were 1st grade, 10,7% were 2nd grade, 11,6% were 3rd grade and 5,4% were 4th grade. The pre-service teachers who favoured the establishment of nuclear power plants, 21,4% of them were male and 18,8% were female. As seen in Table 6, the justifications of the pre-service teachers who made statements in favour of the establishment of a nuclear power plant were evaluated under 'the economic and future role' categories. Although the pre-service teachers expressed an explanation in favour of the establishment of nuclear plants, it was observed that there were issues that they were hesitant about and they made suggestions for these issues. The pre-service teachers' suggestions that plants should be established far away from the city centre, away from forested areas where no one lives, controlled by engineers with sufficient knowledge and experience, waste storage, public awareness, and if necessary, experienced engineers should be brought from abroad are stand out. In addition, a few of the pre-service teachers who expressed an explanation in favour of the establishment of nuclear plants stated that it would be more appropriate to turn to renewable energy sources. A few sample quotations of the pre-service teachers in favour of the establishment of nuclear plants are given below.

"With nuclear energy, not only meet our energy needs, will be met, but also the nuclear facilities in neighboring countries such as Armenia, Iran and Russia will cease to be a threat to us. Turkish people have a negative attitude towards nuclear power plants. The Chernobyl disaster is the main reason for this negative approach. There is no damage in opening nuclear plants after the essential safety precautions are taken. There are nuclear power plants in the leading countries of the world in terms of economy, especially Japan, the USA, Israel and China, and the construction of new ones continues. Turkey is not a rich country in terms of natural resources compared to its environment. We cannot continue to grow as long as we are dependent on foreign energy. Resources such as oil and natural gas will surely run out one day. Then alternative energy sources will gain importance." P88

"Nuclear energy from radioactive materials such as uranium and thorium are quite large, but it continues to emit radiation for many years. It must therefore be stored in lead tombs and special buildings. This is also quite costly." P102

"If it is to be established, it should be far away from settlements and under constant control. In Turkey, they do not even consider it necessary to install filters for harmful fumes coming out of factories, I do not think they will show the same sensitivity for nuclear facilities." P107

4. Discussion and Conclusion

It was found that 55.4% of the pre-service teachers' explanations were gathered in the category of partially scientific explanation, 23.2% of the pre-service teachers' explanations were in the category of scientific explanation, 21.4% of the pre-service teachers' explanations were in the category of unscientific

explanation category. It was seen that the pre-service teachers in the category of unscientific explanation category explained nuclear energy as an inexhaustible source of energy source obtained chemically from fossil fuels and nuclear energy is transformed into electrical energy. Similarly, in the literature, there are studies that determine that students, (Chantharanuwong et al, 2012; Pauzi et al., 2018; Ewim et al., 2023), teachers (Kenar, 2013; Uygur et al., 2023) and pre-service teachers (Kapıcı & İlhan, 2016; Eş et al., 2016; Sağlam, 2022; Sevim & Ayvacı, 2024) do not have the desired level of knowledge about nuclear energy and/or power plants, have superficial knowledge, misconceptions or prejudices. Chantharanuwong et al. (2012) found that most students thought that nuclear energy is transformed into electrical energy, and some students thought that it is the radioactive generated electricity. Ewim et al. (2023) found that 90% of high school students studying in private schools and 74% of high school students studying in public schools knew that uranium is used as fuel in nuclear power plants, while the rest thought that coal is used as fuel. In all levels of explanation, it was found that there were pre-service teachers who defined nuclear energy as an efficient energy that enables the production of electrical energy. There is a widespread opinion that nuclear energy can be a suitable solution to meet the increasing energy demand (Bhanthumnavin & Bhanthumnavin, 2014). Karagöz (2007) determined that despite insufficient, inaccurate and distorted knowledge about nuclear technology and its applications, nuclear energy is given great importance among the options of electrical energy production by pre-service teachers.

It was determined that 41,1% of the pre-service teachers mentioned only the harm dimension of nuclear energy, 38,4% of the pre-service teachers mentioned the benefit-harm dimension of nuclear energy and 20,5% of the pre-service teachers mentioned only the benefit dimension of nuclear energy. The number of 2nd and 4th grade pre-service teachers who mentioned only the harm dimension of nuclear energy were in the majority compared to the 1st and 3rd grades. The male pre-service teachers who mentioned only the benefit dimension of nuclear energy is approximately twice as many as the female pre-service teachers. In addition, it is seen that 2nd grade and 4th grade male pre-service teachers mostly focused only on the benefit dimension of nuclear energy. In all grade levels, it was observed that female pre-service teachers mostly focused on the harms of nuclear energy. This situation reveals that males have more positive opinions about nuclear power plants. This finding is in parallel with the studies of Barke et al. (1997), Özdemir and Çobanoğlu (2008), Yu et al. (2012), Kenar (2013), Kılınç et al. (2013), Mahler and Barber (2013), Ieong et al. (2014), Sürmeli et al. (2017), Akçay and Şavklıyıldız (2023). This result may be due to the fact that female have higher affective attitudes towards the environment than male and, as a result, may have developed negative attitudes towards the construction of nuclear power plants and their impact on the environment. This is supported by the fact that when explaining the effects of nuclear power, the female pre-service teachers mostly focused on the environmental damage caused by nuclear power plants. Corner et al., (2011) stated that people who are generally concerned about global climate change and have a positive attitude towards the environment have negative attitudes towards nuclear energy.

It was seen that the pre-service teachers perceived that nuclear energy would provide economic development, meet energy needs, produce energy and electricity in high amounts and cheaply, and that this energy would be more efficient than other types of energy. In addition, it is thought that nuclear energy will reduce foreign dependency by meeting the energy need, will contribute to power and defence, will bring the country to an important position, and will lead the production of nuclear weapons and technological developments. The pre-service teachers who expressed positive explanations on the benefits of nuclear energy generally expressed their views on economic and political aspects, while their positive views on environmental aspects were limited. Ho et al. (2018) found that most of the participants thought that

nuclear energy emits less carbon emissions, is a stable source, has high efficiency in electricity generation, and will increase economic development. It was observed that no one mentioned this aspect of nuclear energy, which is shown as a cleaner energy compared to fossil fuels, which is one of the important advantages of nuclear energy, and as an environmentally friendly option against greenhouse gas emissions. Nuclear energy is one of the very few energy sources that does not pollute the air and does not emit greenhouse gases, and it is estimated that 2.5-5 grams of carbon is emitted per kilowatt hour produced in all stages of the nuclear fuel cycle, including ore mining, and in the construction of plants. This amount is approximately equal to the amount emitted by renewable energy sources (wind, hydro and solar) and 20-75 times lower than that of natural gas power plants, which are considered to be the cleanest of the available fossil sources (Turkish Energy, Nuclear and Mineral Research Agency, 2024). Although the plant does not emit CO2 when generating electricity, climate change worries have restricted the acceptance of nuclear power plants (Corner et al., 2011; Visschers et al., 2011). Therefore, the extent to which perceptions of climate change have an impact on the acceptance of plants needs to be clearly presented. On the other hand, de Groot et al. (2013) state that personal values, benefit and risk perceptions are associated with the acceptability of nuclear energy. It is stated that people who have altruistic and biospheric values think that nuclear energy has many risks and oppose it, while people who believe that nuclear energy has beneficial results accept nuclear energy. In this case, we can say that although it is claimed that nuclear energy will be useful in combating climate change through lower CO2 emissions, its environmental benefits are not accepted by those with strong biospheric values. It is stated that electricity generation from nuclear plants produces less greenhouse gases to electricity production from carbon-based resources (Kılınç et al., 2013). Nuclear energy is cleaner than coal and gas energy resources, it will benefit the environment and reduce greenhouse gas emissions, particulates and smog. However, the challenge is to ensure the implementation of an appropriate framework mechanism for the management of nuclear energy and nuclear waste (Hayder & Ab Rahim, 2016). On the other hand, Iqbal et al. (2021) state that nuclear energy is not a clean energy source, as its cause a small amount of greenhouse gas emissions during the activities due to the construction and operation of the nuclear plant. Otherwise, in the event of an accident, the environment and people in the environment may be exposed to high levels of radiation and there are various problems associated with the burial of radioactive wastes harmful to human health, which can remain radioactive for thousands of years.

There is no evidence that pre-service teachers are aware that nuclear energy can also be used in the fields of medicine, space, agriculture, food and industry. Pre-service teachers generally expressed that nuclear energy contributes to the production of electricity in economic terms and to the production of nuclear weapons in industrial terms. It was also observed that pre-service teachers focused on the damage that nuclear energy causes to the environment. Pre-service teachers' statements that nuclear energy causes permanent damage, cancer and death, that biodiversity is reduced due to pollution and damage to nature, and that the natural balance is disturbed support this. It was found that pre-service teachers defined nuclear accidents, weaponisation, radioactive waste production, health hazards from radioactivity and terrorist attacks as risks and that the danger of radioactive waste production could outweigh the greenhouse effect. Kılınç et al. (2008) found that many students associated radioactivity with cancer and global warming and thought that radioactive leaks from nuclear power plants worsen global warming. Kılınç et al. (2013) found that about half of Turkish students believe that nuclear power plants can damage living organisms living near them and the majority of students think that nuclear energy makes global warming worse. Jho et al. (2014) found that the majority of students were concerned about radiation and safety around nuclear

power plants, and had negative perceptions of radioactivity and radioactive materials. Hayder and Ab Rahim (2016) found that the majority of university staff and students were concerned about nuclear waste management, quality risks from construction and/or maintenance, control and governance, natural disasters and nuclear accidents. Ateş and Saraçoğlu (2013) found that pre-service teachers had a negative view of the impact of nuclear power plants on the environment and living organisms, believing that if necessary precautions were not taken, nuclear waste would mix with groundwater and that accidents at nuclear power plants would cause radioactive leaks, which would be dangerous to living organisms and cause cancer. Tekgöz and Ercan Yalman (2020) found that teachers have a positive view of nuclear power plants in terms of meeting energy needs and reducing external dependency, but they have a view that the ecosystem may be damaged due to the long-term effects of nuclear power plant explosions. Sağlam (2022) found that pre-service teachers have a positive view that nuclear energy is efficient, emits less greenhouse gases, and may reduce external dependency, but they also have a negative view that there is a risk of accidents in nuclear power plants, radiation leakage harms nature, and external dependency continues due to the use of uranium. Edwards et al. (2019) stated that various negative experiences were identified by the participants and the main reasons for the lack of trust were nuclear pollution and intervention in nuclear accidents. Berényi et al. (2020) found that nuclear energy provides economic benefits, but power plant accidents or disasters affect the social acceptance of nuclear energy. Ewim et al. (2023) found that students do not have a positive view of nuclear power plants due to past destructive events and the influence of social media. This situation explains why future teachers see nuclear power plants as a threat, as the Chernobyl and Fukushima nuclear power plant accidents have negatively influenced their perceptions.

While 59.8% of the pre-service teachers did not want the establishment of nuclear plants, 40.2% of them favoured the establishment of nuclear power plants. It was found that male pre-service teachers were more positive about the establishment of a nuclear power plant and that 4th grade pre-service teachers made more positive statements compared to other grades. It was observed that the reasons of the participants who supported the establishment of a nuclear power plant were mainly economic and the future role of nuclear energy. The participants thought that nuclear energy was an efficient energy that would meet the country's energy needs and contribute to the country's development. Although the participants were in favour of the establishment of nuclear energy, it was observed that they were hesitant about safety, waste, knowledge and experience, and fuel. It was seen that female pre-service teachers who did not want the establishment of nuclear plants were more than male pre-service teachers in all grade levels. It was observed that the reasons given by the participants who expressed the explanation that nuclear power plants should not be established were inexperience and insufficient knowledge as anthropogenic risk, explosion, radiation, leakage as risk from power plant and earthquake as a natural disaster. It was seen that they had the perception that Turkey does not have an adequate technological infrastructure, therefore it would create a security problem, financial resources are insufficient, and in case of any negativity due to radiation concerns, people would be dragged into cancer and permanent damage, it would cause global warming, nature would be damaged, biodiversity would decrease and ecological balance would be disrupted. In addition, some pre-service teachers perceived nuclear energy as a weapon that would bring the end of humanity. By referring to the Chernobyl reactor accident and the Fukushima nuclear accident in Japan, it was determined that the pre-service teachers had the perception that Turkey is an earthquake country and earthquake-resistant structures are not built, and that the possibility of such a disaster is much higher. Nuclear accidents cause negative perceptions about nuclear energy in the society and decrease the perception of confidence in nuclear energy (Greenberg & Truelove, 2011; Siegrist & Visschers, 2013). Ho et al. (2019) found that

trust significantly affects the public's perception of the benefits of nuclear energy, while perceived risk plays a more effective role than perceived benefit in the acceptance of nuclear power plant. It is stated that the perception of benefit is important in the acceptance of nuclear power plants (Jang & Park, 2020; Zhu et al., 2020), the region where the nuclear power plants will be built plays an important role in the acceptance of the plants (Alzahrani et al., 2023), and the perception of risk has a negative effect on the acceptance of nuclear power plants (Yıldız & Arı, 2019). Belmonte et al. (2023) stated that the participants perceived the benefit of the nuclear power plant slightly higher than the perceived risk and therefore nuclear power plant was considered as an alternative source of electrical energy.

Pre-service teachers who expressed their explanations in favour of the establishment of nuclear plants emphasised that nuclear plants should be established far away from the city centre, away from forested areas where no one lives, that they should be controlled by engineers with sufficient knowledge and experience, and that experienced engineers and staff should be brought from abroad if necessary. Hao et al. (2019) mentioned that living near to nuclear plants has a negative effect about the admission of nuclear energy. Dikmenli et al. (2019) found that the majority of the lecturers stated that nuclear plants should be established, but that did not desire to live in the immediate vicinity of nuclear power plants. In addition, some of the pre-service teachers stated that they had hesitations about the storage of wastes and the fact that the country is not rich in raw materials, that foreign dependency would not decrease and that this would be costly, and that the country's budget is troubled. Contrary to this view, 11 pre-service teachers emphasized that uranium and thorium are used for nuclear energy, that Turkey is very rich in raw materials and that the contribution to the country's economy would be quite large. Uranium is the basic nuclear fuel raw material. Seven per thousand (0.71%) of the uranium in nature contains the fissile (fissile) uranium-235 isotope. Thorium, on the other hand, cannot be used as nuclear fuel on its own because it is not a fissile substance, and it needs a trigger (neutron) in order to transform into U233, a fissile isotope. Therefore, it must be used together with fissile isotopes U235 or Pu239 in order to be used as nuclear fuel. In addition, there is no commercial-scale power plant operating with thorium today, and as a result, the consumption of thorium as an energy raw material is almost non-existent. The economics of a thorium-based fuel cycle can be made possible by a nuclear programme involving a large number of power plants. Thorium-based power generation requires the construction of facilities that require high investment and operating costs. Since each of these facilities is not economical under today's conditions, commercial scale technologies have not yet been developed in the world (TENMARK, 2024). Although Turkey ranks second in the world in thorium reserves, the contribution of thorium to the national economy as nuclear fuel is not in question for the time being.

Some of the pre-service teachers, who mentioned only the damage dimension of nuclear energy and did not want the plants to be established, stated that they did not have a favourable view of nuclear energy after Chernobyl because cancer cases were seen in their families, relatives or close relatives and they lost their loved ones, but after the Fukushima disaster, they thought even more negatively. It is obvious that it will not be easy to change these pre-service teachers' views on nuclear energy. The pre-service teachers who expressed an explanation in favour of the establishment of nuclear plants stated that they should raise public awareness as a suggestion, because there is a negative perception towards nuclear energy, and this is due to the information pollution in the press and social media due to the Chernobyl and Fukushima disasters. After the Fukushima nuclear power plant accident, negative perceptions increased due to the frequent coverage of negative information about direct and indirect effects such as radiation pollution in seafood, radioactive concentrations in the atmosphere, and confident food for next generations in the news

media (Han et al., 2015). Therefore, the issue of nuclear energy needs to be addressed in an effective and credible manner that will ensure public support (Adamantiades & Kessides, 2009). In addition, although a few of the pre-service teachers expressed an explanation in favour of the establishment of nuclear plants, it was observed that they emphasized that it would be more appropriate to turn to renewable energy sources. Lee and Yang (2013) determined that the majority of technology teachers in Taiwan opposed nuclear plants, and preferred the use of renewable energy sources such as wind and solar. Berényi et al. (2020) determined that the higher education students supported solar energy, but the trust in nuclear energy was low, except for its future role, and nuclear energy was the last choice of the participants. There are similar studies in the literature that concluded that alternative energy sources should be preferred as priority energy sources instead of nuclear energy sources (Palabıyık et al., 2010; Greenberg & Truelove, 2011; Lee & Yang, 2013; Akşan & Çelikler, 2018; Dikmenli et al., 2019). Conversely, given the need to decarbonise the world's energy supply, many believe that nuclear plant will remain or increase as an important constituent of the overall energy mixture in the coming period (Harris et al., 2018). According to Visschers et al. (2011), alternative energy sources are still unable to generate adequately energy to provide the world's requirements and are considerably expensive. At this point, since renewable energy sources are not continuous and depend on geographical location and climate, hybrid nuclear-renewable energy is seen as a remarkable option. It can be argued that combining nuclear energy and renewable energy in a single hybrid energy system by combining them with IT connections will allow the disadvantages that arise in their operation alone to be eliminated (Suman, 2018).

5. Recommendations

People's high level of awareness about nuclear energy allows them to evaluate its benefits and consequences rather than misinterpreting and worrying about the risks of nuclear energy production. Therefore, accurate information about nuclear energy and its technologies should be continuously announced to the public and at the same time, people's need for nuclear information should be met (Pauzi et al., 2018). Skamp et al. (2019) suggested that more education on renewable and nuclear energy sources could help students become more aware of reducing global warming, while in countries where education is less useful, other persuasion methods such as social media marketing, taxation and legislation should be considered. Tekgöz and Ercan Yalman (2020) found that teachers were initially apprehensive about the construction of a nuclear power plant, but over time they became generally positive due to the active promotional campaigns in the region. Uygur et al. (2023) found that the activities led to a positive change in science teachers' knowledge and attitudes towards nuclear energy. Harris et al. (2018) found that those who were knowledgeable about nuclear energy technology had mostly positive views about nuclear safety. Brown (2018) found that most students were concerned about radiation and the safety of nuclear energy, but had no educational or personal experience with nuclear radiation or nuclear power plants to form these views, and they showed more positive attitudes after visiting nuclear power plants. In this context, it can be recommended that pre-service teachers frequently attend scientific events such as seminars, conferences, symposia and panels organised by experts in the relevant socio-scientific field, which will enable them to obtain more detailed information on socio-scientific issues such as nuclear energy. In addition, socio-scientific literacy can be promoted by ensuring participation in out-of-school activities, such as live and virtual educational trips to facilities set up to raise awareness of the operating principles of nuclear power plants, their benefits and harms, and how they should be used in the light of scientific knowledge, and by making in-service activities sustainable.

The pre-service teachers mostly focused on energy production in their positive explanations on nuclear energy, did not give examples of its use in scientific fields (medicine, agriculture, technology, etc.), and focused on the dimension of harm to people healthy and harm to the environment in their negative explanations. Es and Varol (2019) stated that the participants who supported nuclear energy mostly produced justifications in the fields of economy, while those who opposed it mostly produced justifications in the fields of environment. Hu et al. (2021) stated that environmental apprehension and belief in energy scarcity were the main decisive of psychological sensation and public acceptance. Hayder and Ab Rahim (2016) found that when respondents were asked whether they would support nuclear energy if it could reduce the effect of climate change, the number of supporters increased by 21 per cent. At this point, when convincing concrete information about the positive impact of nuclear energy on climate change is presented and awareness is raised about the positive results of nuclear energy, it can contribute to the formation of pre-service teachers' positive perception towards nuclear energy. Wang and Li (2016) emphasise that energy supply, environmental risks and benefits, and trust are decisive of university students' admission of nuclear energy and find that emphasising the benefits of nuclear energy in energy supply increases the level of admission when communicating with students. A high level of sense of the requirement and safety of nuclear energy create a high level of admission of nuclear power production (Han et al., 2014). The higher the sensed benefits of nuclear energy, the higher the admittance of nuclear energy (de Groot et al., 2013). The perception of the benefits of nuclear energy is positively associated with the level of acceptance (Wang & Li, 2016), it is thought that it is important to provide a satisfactory level of information on the usefulness of nuclear plants in the acceptance and support of nuclear energy.

It has been stated in the literature that the media and social media are effective in forming information and opinions about nuclear power plants (Gardner, 2008; Eş et al. 2016; Ho et al., 2019; Sürmeli et al. 2017; Dikmenli 2019; Tekgöz & Yalman, 2020; Zhu et al. 2020; Uygur et al. 2023; Ewim et al. 2023). Since people generally obtain information about energy resources and gain awareness about the topic from the media, the media plays a major role in providing accurate information and awareness (Akçoltekin & Doğan, 2013). The fact that pre-service teachers frequently mention social media and news when talking about nuclear power plants and their impact on the environment shows the importance of the media in creating awareness about these issues (Akşan & Çeliker, 2018). Therefore, getting the support of the media and acting in co-operation is thought to have an impression on admittance of nuclear energy. In addition, it is thought that in order to prevent information pollution in social media and the press, false information and content should be controlled and an effective public opinion should be created to process socio-scientific issues more accurately. Also, given the ability of science, technology, engineering and maths professionals to influence people's perceptions, they can be effective in guiding people's opinions about nuclear energy (Harris et al., 2018). At this point, it is recommended that media programs be increased and repeated periodically to bring together STEM professionals, nuclear scientists, environmental organizations and the public and inform them that nuclear energy is critical in terms of its benefits and risks and that nuclear waste can be adequately managed with the country's existing technology. In addition, it was found that most female pre-service teachers did not view the construction of nuclear power plants favorably, which was attributed to their perception of health risks and social roles. It was found that female tend to perceive the severity of technical risks higher than male due to their social roles, as they perceive the risks of nuclear power plants mostly according to their living conditions and daily activities (Ieong et al., 2014). In this case, the employment of female in nuclear power plants may have some effect on changing female's perspectives.

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