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# A Metaphoric Study on Classroom Teacher Candidates' Perception of Nuclear Power Plants in a Socio-Scientific Issues-based Environmental Education Class

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## Abstract

The purpose of this study is to determine the metaphors that the candidate teachers develop about the nuclear power plants in a socio-scientific issues-based environmental education class and the justification of these metaphors. The study was constructed on the basis of a qualitative research model and phenomenological (phenomenology) pattern was used. The study was conducted during an academic semester in the environmental education course. The researcher presented to the classroom teacher candidates the positive and negative effects of the socio-scientific situations on environment, human development, economy, and health. It was ensured that teacher candidates were able to relate these issues to the subjects of environmental education course, assess the difficulties and discuss them with large group studies. A study for building the metaphors was conducted in the activity carried out for nuclear power plants as the last activity of the implementation process. The research was conducted with 197 classroom teacher candidates and the data were collected through a metaphor questionnaire prepared in a semi-structured form and the content analysis method was used in data analysis.

**Keywords:** Environmental education, metaphor, nuclear power plants, socio-scientific issues

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## INTRODUCTION

With the development of science and the advancement of technology, the life of humans becomes easier, however, some problems come along with these developments. These problems are the issues that need to be discussed in terms of their scientific nature and the environment and society that they affect. These problems can create a dilemma so that it would be impossible to consider as wrong or right, to find a single solution and to take a common decision. A newly produced vaccine, GMO foods developed as a remedy for hunger, cloning of living tissues or shifting to alternative sources of energy certainly have a direct impact on society and it is necessary to consider these factors. The controversial social issues, which relate to science and society and are ill-structured, open-ended problems having multiple solutions are considered as socio-scientific issues (Sadler, 2003; Tüzün, 2013; Sağlam, 2016). While these issues are a product of scientific knowledge, it is not possible to give definite answers since they are related to many aspects of society. Hence, they are accepted as controversial issues (Topçu, 2010). Scientific studies can directly or indirectly affect society, it is necessary to consider the opinions of the society since it is not possible to consider separately the science, technology, and social structure (Sürmeli, Duru & Duru, 2017). Consequently, the individuals compare the different dimensions and related disciplines when evaluating the socio-scientific issues and these issues encourage them to think in a multidimensional level (Çavuş, 2013).

With the improvements in technology, people strive to dominate nature and strive to facilitate the life. On the other hand, governments aim to grow in every field so that they can provide a better life for the citizens and they use the energy as a prominent input. Because energy is used in many areas such as industry, transportation, residence, and health, it is regarded as the basic requirement for fast economic growth and development. However, this requirement increases the need for energy resources. For solving the energy problems that the Governments may encounter, they tend to increase the number of power plants they use and renewable or non-renewable energy sources (Aksan & Çeliker, 2018; Yılmaz & Bilge, 2018). Hence, nuclear power plants are one of the alternative energy sources that countries establish for producing energy.

In nuclear energy, enormous amounts of energy are released by splitting the heavy radioactive atoms as the fission reactions into smaller atoms by the collision of a neutron or by the fusion reaction of light radioactive atoms forming heavier atoms (Sağlam, 2016). In nuclear power plants, the neutrons in the fission reaction are reactivated again and the continuity of nuclear power generation is ensured (Ministry of Energy and Natural Resources, 2010). Accordingly, the enormous amount of energy produced from nuclear power plants is regarded as an alternative to fossil fuels both because of their high economic contribution and their lack of carbon emissions (Benzer & Şahin, 2012). Some countries even fulfill most of their energy needs from their nuclear power plants. While France derives over 75% of its electricity from nuclear energy, the USA derives 15% of its electricity from nuclear energy. There are more than 400 nuclear power plants around the world and more than 100 are located in the USA (TEİAŞ, 2011). When evaluated in terms of Turkey, the increase in the urbanization, population growth, supply and demand and the expansion of the manufacturing sector can trigger an energy crisis in the future. Hence, it is recommended to use nuclear energy alongside the other energy sources to fulfill the energy demand requirements (Temurçin & Aliağaoğlu, 2003; Udum, 2010). In order to meet the energy needs of the country in the future, the establishment of nuclear power plants is among the country's principal political goals. For this purpose, it is planned to increase the energy production by the commissioning of the nuclear power plants to be established in Akkuyu and Sinop until 2023 (Ministry of Energy and Natural Resources, 2010).

While energy policies to satisfy the energy needs through nuclear power plants are argued to be cheaper and less polluting from an economist point of view, there are also intense reactions to the establishment of these power plants under the influence of environmentalist groups in many countries (Sürmeli, Duru & Duru, 2017). The reactions are based on the presence of radioactive substances used to release nuclear energy. The negative effects of the radiation emitted by these substances on human and the environment are the principal reasons for these concerns. The radioactive waste used as fuel carries a high risk and cannot be entirely destroyed. It is probable that this waste can be fragmentized

and leaked into natural environments (groundwater, river, sea, drinking water) even if the waste is stored in the steel plates and buried underground. Furthermore, the potential risks of this energy source are introduced as being exposed to natural disasters such as earthquakes, floods, tsunamis or terrorist attacks in the reactors (Benzer & Şahin, 2012; Yapıcı, 2015).

The establishment of nuclear power plants and their use in the energy sector become a socio-scientific issue, when evaluated from two different perspectives. While some people defend the "nuclear renaissance" and the energy production through nuclear power plants, also argue that nuclear power plants are the cleanest source of energy in preventing global warming when releasing enormous amounts of energy. On the other hand, the view of "nuclear nightmare" focuses on the safety of the power plants and the indestructible nature of the waste and hence, these people highly oppose to the establishment of nuclear power plants while they argue that the current power plants should be shut down (Aygün, 2005). It is expected that individuals will create solutions with sustainability consciousness in the solution of environmental problems in terms of science education for these controversial issues. This can only be achieved if the socio-scientific subjects are included in the curriculum or if the educational approach focuses on socio-scientific subjects, or if the educational model is used in the science course (Bakırcı et al., 2018). Many institutions and organizations in the world emphasized the significance of teaching socio-scientific subjects and including these subjects into the science programs, presenting them to students, discussing, analyzing and raising awareness about these issues (American Association for the Advancement of Science [AAAS], 1990; National Research Council [NRC], 2012; Ministry of National Education [MEB], 2013; 2018). Accordingly, it is valuable for the science education program in Turkey that the students are aware of the socio-scientific issues that influence the environment and environmental issues since they start their basic education, that the students can comprehend the issues correctly and discuss them (MEB, 2018). Several alternative methods can be used in science to receive the opinions, comments, and perspectives of the students on socio-scientific issues. Researchers and practitioners often use metaphoric thinking, one of these alternative methods.

The reason why metaphors are used in educational research is it is possible to demonstrate and explain a concept or situation in order to communicate effectively with the target audience (Midgley & Trimmer, 2013). Individuals want the audience to comprehend their ideas and expect that these ideas influence the audience permanently. In this case, the individuals develop various ways to explain the concepts, thoughts, and emotions they want to express and make efforts to explain clearly (Yıldızlı, et al., 2018). It is possible to depict the situations and concepts that are similar through the metaphors or to compare the situations or concepts, where there is no similarity (Özgürbüz, 2013). Metaphors explain an experience with a more well-known experience, to describe a concept or an expression in a way that the concept or the expression is more easily understood (Lakoff & Johnson, 2005). Metaphors are individual outcomes containing explanations, where individuals can use their knowledge and ability to think differently due to their powerful cognitive structure (Ekici & Akdeniz, 2018). Consequently, the metaphor created on any concept is truly the reflection of the person's interest, who creates the metaphor. Thus, a new dimension is opened for whatever needs to be explained and the concept, thoughts, and feelings become more understandable and permanent

According to Morgan (1998), metaphors extend the imagination of a person by generating powerful insights and encourage the person to think and behave differently. Insight is reached through metaphors, thereby enables new possibilities and opportunities to develop. For efficient learning, it is necessary to develop thinking skills, gain the expected positive attitudes and use these attitudes and behavior acquired in daily life (Martin, Sexton & Franklin, 2009). It initiates a cognitive process for both readers and listeners by the use of metaphors. The developing cognitive process triggers the affective effect while the processes influence each other. This certainly proves the power of influence of the metaphors on the individual (Yazar, Özekinci & Lala, 2017) and it enables more efficient learning. Through metaphors, thoughts and experiences are shown in a more understandable way by supplying the justifications as well (Ho, 2005). In order to ensure effective learning in science education, the metaphorical thinking activities can be used for determining the meanings attributed to concepts and justifications.

It is assumed that teachers and teacher candidates who will raise awareness about socio-scientific subjects have sufficient knowledge about the socio-scientific issues and that these issues will be discussed and interpreted in the class and presented to students with various teaching techniques (Eryaman, 2006). When the relevant national studies are considered, several studies have been determined about the nuclear energy for teacher and teacher candidates (Aksan & Çeliker, 2018; Ateş & Saraçoğlu, 2013; Demircioğlu & Uçar, 2014; Kutluca, 2016; Özdemir, 2014; Özdemir & Çobanoğlu, 2008; Sağlam, 2016; Sürmeli, Duru & Duru, 2017; Şenyuva & Bodur, 2016; Turan, 2017). The study focuses generally on the concept of energy, which is essential in building a sustainable environmental awareness while it focuses particularly on the metaphorical perceptions of the classroom teacher candidates about the nuclear energy plants, which are under construction and highly discussed in the public during the environmental education course that is structured according to the socio-scientific approach. The principal source of knowledge of the students, who will encounter socio-scientific subjects for the first time in their educational life is certainly the classroom teachers. Hence, the researcher considers that it is important to inform the classroom teacher candidates on socio-scientific issues for raising their awareness about the environment since they have been received the environmental education course during their undergraduate education. It is also essential that the candidates earn experience through an activity about the metaphorical thinking by using a socio-scientific approach.

The purpose of this study is to determine the metaphors that the candidate teachers develop about the nuclear power plants in the socio-scientific issues based environmental education class and the justification of these metaphors. Within this scope, the answers to the following questions were sought::

1. What are the metaphors that the classroom teacher candidates have related to nuclear power plants?

2. What are the justifications that the classroom teacher candidates use for the nuclear energy plants, how can we categorize them?

3. What are the characteristics of the justifications that the classroom teacher candidates use for the nuclear energy plants?

## METHODOLOGY

### Research Model

Based on the qualitative research model, the study uses the phenomenological pattern. In this pattern, the perceptions and reactions of individuals to various events such as phenomena, concepts, perceptions, experiences, and situations that may be encountered in the world can be analyzed in depth. In the phenomenology pattern, we focus on the phenomena that we are aware of, but we do not have the in-depth knowledge (Fraenkel, Wallen & Hyun, 2012; McMillion, 2000; Yıldırım & Şimşek, 2013). In this design, the researcher examines the perceptions of the participants and the meanings attributed to the concepts and aims to determine the facts without going to a generalization (Akturan & Esen, 2008; Patton, 2014). On the other hand, this study determines the justified perceptions of the classroom teacher candidates about the nuclear power plants.

### Application Procedure

The application procedure is designed in two stages as structuring the Environmental Education course as socio-scientific issues and the creation of the metaphors. The researcher conducted the study with the teacher candidates, who had taken the Environmental Education course.

While Environmental Education courses for teacher candidates contain the activities of ecosystems, they also include natural resources development such as soil, water, and forest and protection activities. Consequently, it is aimed to render teacher candidates efficient and volunteer participants in environmental management (Peyton, et al., 1995; Ünal & Dımışkı, 1999).

With the advancement of technology, many socio-scientific situations that may have a positive or negative influence on the environment and human life can constitute the subject of Environmental Education course (Eryaman, et all, 2010). The researcher identified the socio-scientific issues generally discussed in the public among the subjects of the Environmental Education course. These issues are as follows; electric-powered/gasoline-powered vehicles, use of plastics, GMOs, hydroelectric power plants, solar panels, cloning, vaccination, and nuclear power plants. The researcher showed with an impartial perspective the positive and negative impacts of socio-scientific subjects on areas such as environment, human, development, economy, and health to classroom teacher candidates. Within the framework of these socio-scientific issues, the researcher administered the course of Environmental Education during an academic period. Afterward, the classroom teacher candidates are expected to relate the courses with exemplary socio-scientific issues, to have knowledge about these issues and to evaluate these contradictory situations. Then, teacher candidates are asked to express their opinions about the socio-scientific issue that is presented as the group discussion activity and to share the issue with other teacher candidates. Hence, the opinions of classroom teacher candidates constitute the main focus of the courses. This process has been applied in two periods of the course.

During the last activity of the application procedure, the process has been designed in the form of metaphor formation instead of large group discussion in the activity on nuclear energy plants. Before conducting the study, teacher candidates were informed about the use of metaphors as a teaching activity in the educational studies. The definition of metaphor, the purpose of use, the subjects to be considered in the learning-teaching processes and examples of their implementation are presented. After this process, 15 minutes were given to the teacher candidates that are volunteered to participate in the study and the candidates created their own metaphors for nuclear power plants and showed the justifications for the metaphors they have created.

**Study Group**

This research was carried out with 197 classroom teacher candidates enrolled in a faculty of education of a university in Central Anatolia. In order to minimize the difficulties that may occur, the purposive sampling method was used. When creating the purposive sampling group, the following criteria are taken into consideration: the accessibility of the researcher to the study group, if the teacher candidates take the socio-scientific based environmental education class and the enthusiasm of the teachers to participate in the study.

**Data Collection Instrument**

The researcher collected the data of the study via the metaphor form, prepared in a semi-structured way. The metaphors created by the participants cannot reflect independently the descriptive and visual strength, and after the process of metaphor formation, it was necessary to ask the question "why" (Yıldırım & Şimşek, 2013). Consequently, the expression of "because" can be reflected the participants so that they can provide the justification of the metaphor (Ekici and Akdeniz, 2018). Hence, the teacher candidates participated in the study were asked to finish the sentence as follows, *"The nuclear energy plants are like ..... Because ……",* The metaphor form designed in this way will be able to determine the perceptions of the classroom teacher candidates about nuclear power plants together with the justifications.

### Data Analysis

Content analysis technique was used to analyze the data in this study. Content analysis is a research tool used to determine the presence of certain words, themes or concepts within some given qualitative data (Sönmez & Alacapınar, 2014; Yıldırım and Şimşek, 2013). Before starting the data analysis, all data were numbered as TC-1, TC2, TC-3, etc... Subsequently, the justifications of the metaphors created by the teacher candidates were coded. Among these codes, themes that own meaning and integrity were developed, which reflect the perceptions of teacher candidates based on a logical basis. Then, we have defined the category, in which the justifications will be evaluated. An example of the generated code and themes is presented in Table 1.

**Table 1.** List of themes, categories, and codes

| Theme | Sub-theme | Categories | Examples related to the codes |
|---|---|---|---|
| Positive Characters of Nuclear Power Plants | Environmental Impact<br>Economic Benefit | Prejudiced<br>Impartial<br>Uncertain | Efficiency, development, cost reduction, power, carbon emission, air pollution reduction, etc. |
| Negative Characters of Nuclear Power Plants | Environmental Risks<br>Economic Factors | | Explosion, natural disaster, accident, leakage, initial organization cost, production of the weapons, etc. |

In line with the aim of the research, metaphors e aim of the research, metaphors, and justifications of the teacher candidates are categorized based on themes and the data was interpreted after calculating the frequencies. Furthermore, the word cloud is presented to show the findings of the research and the direct quotes from the candidates so that the opinions of the candidates are reflected in the most effective way.

### Validity and Reliability

When analyzing the qualitative data or reports, other specialists can be included in the study in order to make evaluations and ensure reliability (Fraenkel, Wallen & Hyun, 2012). For this purpose, an expert was included by the researcher to the study for completing the encoding requirement and for categorizing the metaphors that the teacher candidates have created. After the individual analyses of the researcher and the encoding specialist, the reliability estimation [Reliability = Consensus/(Consensus + Disagreement)] proposed by Huberman (1994) was calculated. If this value is higher than 70% and above, it means that the reliability in qualitative research is achieved. At the end of the calculation, the reliability of 88% was achieved, and in the no-consensus disagreement, the encoding specialist and the researcher provided a coding together and they have reached the consensus. In addition to this, the process starting from the design to the conclusion of the study at the transmissibility point has been precisely and clearly reported, and the findings are presented to the reader in an explanatory manner with tables and direct quotes. The findings collected in order to increase the consistency of the research were interpreted and the connections with other findings in the literature were ascertained. In order to ensure the confirmability of the research, it is explained in detail how the data is collected and how the data is analyzed.

## FINDINGS

In this section, the metaphors declared by the class teacher candidates for nuclear power plants, the justifications of these metaphors and the categorical evaluation of the research justifications are presented under the headings.

### Findings About the Created Metaphors

The metaphors created by the teacher candidates for nuclear power plants are displayed in Table 2.

**Table 2.** Metaphors of Classroom Teacher Candidates About Nuclear Power Plants

| Order of the Metaphor | Metaphor Name | f | Order of the Metaphor | Metaphor Name | f |
|---|---|---|---|---|---|
| 1 | Love/Being in love | 15 | 31 | Natural disasters | 2 |
| 2 | Internet | 14 | 32 | Money | 2 |
| 3 | Getting married | 13 | 33 | Iceberg | 1 |
| 4 | Using medication | 11 | 34 | Cancer | 1 |
| 5 | Gun | 9 | 35 | Teacher that cannot be assigned | 1 |
| 6 | Frenemy | 9 | 36 | Support column | 1 |
| 7 | Using a phone | 8 | 37 | Ginger | 1 |
| 8 | Eating dessert | 8 | 38 | Blank paper | 1 |
| 9 | Bomb | 7 | 39 | Getting a diploma | 1 |
| 10 | Gambling | 7 | 40 | Going out in the cold weather | 1 |
| 11 | Smoking | 7 | 41 | Putting on Make up | 1 |
| 12 | Technology | 5 | 42 | Azrael | 1 |
| 13 | Alcohol | 4 | 43 | Poisonous gases | 1 |
| 14 | Thorny rose | 4 | 44 | Discount product | 1 |
| 15 | Human | 4 | 45 | Sea | 1 |
| 16 | Fire | 4 | 46 | Diamond | 1 |
| 17 | Bee | 4 | 47 | Making pottery | 1 |
| 18 | Eating bread | 3 | 48 | Going to school | 1 |
| 19 | Scientific experiment | 3 | 49 | Hate | 1 |
| 20 | Wild animal | 3 | 50 | Sun | 1 |
| 21 | Getting on the plane | 3 | 51 | Driving a car | 1 |
| 22 | Using salt | 3 | 52 | Motherless child | 1 |
| 23 | Using coal | 3 | 52 | Writing | 1 |
| 24 | Power | 3 | 54 | Cheating | 1 |
| 25 | Change | 3 | 55 | Putting on perfume | 1 |
| 26 | Disease | 2 | 56 | Night-day | 1 |
| 27 | Wearing a mask | 2 | 57 | Finding a treasure | 1 |
| 28 | Snake | 2 | 58 | Moving | 1 |
| 29 | Police | 2 | Total | | 197 |
| 30 | Doctor intervention | 2 | | | |

When Table 2 is analyzed, it has been concluded that class teacher candidates created 197 metaphors in 58 different classifications related to the nuclear power plants. The first ten ranks of the metaphors used by the classroom teacher candidates about the nuclear power plants consist of the following categories; love/falling in love, internet, getting married, using medication, weapon, frenemy, using a phone, bomb, eating dessert, gambling, and smoking. While 32 of these metaphors were repeated twice or more than twice while 26 metaphors were created only once. In general, metaphors containing an action (such as falling in love, getting married, smoking, etc.) are more created by teacher candidates than by metaphors including concepts (internet, technology, scientific experiment, etc.). If we pay attention to the following metaphors are very related to the age of the

teacher candidates and they are the concepts that the teacher candidates are highly interacting with; falling in love, internet, getting married, using the phone, smoking, using medication, etc. Consequently, the teacher candidates mostly formed metaphors about their close circle.

**Findings Related to the Justifications of the Metaphors**

Table 3 presents the findings related to the categories of the justifications of the metaphors that teacher candidates used for nuclear power plants.

**Table 3.** Categories of the Justifications of the Metaphors that the Teacher Candidates Used about the Nuclear Power Plant

| Categories | Justifications | Metaphors | (f) | Total (f) |
|---|---|---|---|---|
| In favor of Nuclear Energy Power | Justifications that fully support | Power (3), Sun, Diamond, Support column | 6 | 65 |
| | Justifications Taking into Consideration the Risks | Using the phone (6)*, Using medication (6)*, Technology (5), Thorny rose (4), Love/falling in love (4)*, Bee (4), Internet (4)*, Wild Animal (3) , Change (3), Doctor intervention (2), Natural disasters (2), Police (2), Putting on Make up, Getting a diploma, Cold air, Blank paper, Ginger, Band-aid, Writing, Finding treasure, Driving, Going to school, Getting on a plane*, Eating dessert*, Human*, Fire* | 59 | |
| Neutral to the Nuclear Power Plant | Uncertain Justifications | Getting married (10)*, Weapon (9), Internet (8)*, Love/Being in love (7)*, Human (3)*, Fire (3)*, Scientific experiment (3), Gambling (3)*, Using coal (3), Using medication (2)*, Using a phone (2)*, Getting on a plane (2)*, Night-day, Teacher that cannot be assigned, Moving, Making pottery, Sea, Money*, Snake* | | 62 |
| Opposed to Nuclear Power Plant | Justifications taking into consideration the Supporters | Friendly looking enemy (9), Eating dessert (8), Smoking (7), Using medication (4)*, Love/Falling in love (4)*, Alcohol (4), Gambling (4)*, Getting married (3)*, Using salt (3), Bomb (3)*, Eating a bread (3), Internet (2)*, Wearing mask (2), Discounted product, Iceberg, Cheating, Motherless child, Putting on perfume, Snake*, Money* | 60 | 70 |
| | Completely Rejecting Justifications | Bomb (4)*, Disease (2), Cancer, Hate, Azrael, Poisonous gas | 10 | |

* Metaphors having different justifications.

When the justified answers given to the metaphors of the classroom teacher candidates in Table 3 are considered, it is comprehended that whether the metaphors are in favor of nuclear power plant or they are neutral or they are opposed to the nuclear power plant. Although there are many justifications provided as opposed to the nuclear power plants (f= 70), however, it is ascertained that the numbers in three categories are very close to each other (f= 65; f= 62; f= 70). Moreover, it was ascertained that classroom teacher candidates could also take into account the risky areas of nuclear power plants in the justifications they have created for metaphors (f= 59), while it was determined that they could take into account the positive aspects that are in favor of the nuclear power plants (f= 60).

Since the teacher candidates who are neutral to nuclear power plants can take into account the positive and risky aspects (f=62), it has been comprehended from their answers that they cannot make any decision. While 181 teacher candidates among the participants (sum off=59, f=62 and f=60) could take into account the risky and positive aspects and could evaluate the different aspects of the subject, 16 teacher candidates (sum off=6 and f=10) used a unilateral perspective. From this point of view, classroom teacher candidates were able to recognize nuclear power plants as a significant socio-scientific issue; have been able to take into account the positive and negative effects of nuclear energy in terms of the production, use, and its reflections on the environment and economy. Examples of metaphors created by the classroom teacher candidates and the justifications in the determined categories are presented below.

Classroom teacher candidates, who were determined to be in favor of the nuclear power plant by the justifications they used, created 6 metaphors and used *"power"* metaphor at the most.

> *".... is like power. Because we will earn many things when we use this. Since there will be economic contributions, we will become a stronger country" (TC-121).*

> *".... is like power. We will be stronger the economic and military field when we have the nuclear power. In this period when the political wars prevail, we will be relieved with nuclear power" (TC-75).*

Classroom teacher candidates, who were determined to be in favor of nuclear power and who didn't ignore the risks of the power plants, created 59 metaphors and used *"using a phone", "using the medication"* and *"technology"* metaphors at most.

> *"... is like the phone. It has both benefits and damages. You need money to buy it and it emits radiation. Since the phone brings more benefits than damages, we all use the phone. Consequently, the benefits of nuclear power plants are so many and they should be established in our country" (TC-17).*

> *"... is like using medication. Because it's necessary when we're sick, we need it. However, there are side effects as well as damages. When used accurately and safely, the medication is beneficial and it is indisputable that it will bring us benefits" (TC-43).*

> *"... is like the technology. We have increased our living standards by acquiring new knowledge. Today, technology is indispensable for our lives. However, technology can serve according to the different tastes of the people while it can be used badly and it can be addictive. Nuclear power must also be used, it is possible to minimize the damage by taking precautions" (TC-160).*

Classroom teacher candidates, who were determined to be neutral to nuclear power and who didn't ignore the risks and the positive aspects of the power plants, created 62 metaphors and used *"getting married", "gun", "internet"* and *"love/being in love"* metaphors at most.

> *"... is like getting married. Because marriage is expensive in the beginning, it signifies power. If the marriage is not managed well, the marriage will harm couples, their health, their psychology, and their families as well. Nevertheless, if the appropriate conditions are provided, there will be benefits of the marriage. It is costly to establish nuclear power plants, and if it does not have proper conditions, it will greatly harm the environment. If these favorable conditions are met, it provides good benefits to the country, just like the marriage does" (TC-91).*

> *"... is like a gun. Whoever has the weapon has the power ultimately. However, the possibility of a burst scares the human" (TC-108).*

*"... is like the internet. If it is used in the right place at the proper time, it will be profitable to humanity. But if it is not used correctly, it will be harmful for humanity" (TC-8).*

*"... is like falling in love. Although it feels good in the beginning, it will bring harm if there is too much love. We always want more. It is the same for the nuclear energy. There is certainly a need for energy, but we also damage the environment with excessive energy production. We tend to get bored if we receive too much attention. Then, it will be harmful to us and to our partner as well" (TC-180).*

Classroom teacher candidates, who were determined to be opposed to nuclear power plant and who didn't ignore the positive aspects of the power plants, created 60 metaphors and used *"frenemy"*, *"eating dessert"* and *"smoking"* metaphors at most.

*"... is like a frenemy. Because you think that this is friendly, maybe it brings benefits to you, however, it secretly poisons you. This is the same for nuclear power plant. There are hidden damages, that's why we shouldn't establish the power plants" (TC-143).*

*"... is like eating dessert. Because our body needs desserts but people always eat too much and the sweets greatly harm our health" (TC-82).*

*"... is like smoking. Because when you smoke, you like it and you don't realize that you smoke. But ultimately, the results are deadly" (TC-150).*

Classroom teacher candidates, who were determined to be opposed to the nuclear power plant and who thought unilaterally created 10 metaphors and used *"bomb"* and *"disease"* metaphors at most.

*"... is like a bomb. The bomb is given to you. With the slightest mistake, you use your life. You can't repair your mistake" (TC-113).*

*"... is like a disease. It is like a person that feels weak and dominated by the germs, the nuclear energy plant signifies the germs and evil" (TC-47).*

**Findings Related to the Characteristics of the Justifications**

Table 4 presents the findings of the justifications characteristics that classroom teacher candidates created about the nuclear power plants.

**Table 4.** Characteristics of the Justifications that Classroom Teacher Candidates Created for Nuclear Power Plants

| Theme | Sub-theme | Justifications | (f) | Total (f) |
|---|---|---|---|---|
| Positive aspects of nuclear power plants | Economic benefit | High energy efficiency | 40 | 144 |
| | | Enabling economic growth | 32 | |
| | | Fulfilling the energy needs | 24 | |
| | | Cheap energy | 13 | |
| | | Power generation | 10 | |
| | | Providing energy independence | 8 | |

| | | | | |
|---|---|---|---|---|
| | Environmental effects | No carbon emission | 12 | |
| | | Beneficial* | 5 | |
| Negative aspects of nuclear power plants | Environmental Risks | Risk of accident/explosion | 57 | 166 |
| | | Risk of disease | 40 | |
| | | Leak risks | 28 | |
| | | Natural disaster risk | 11 | |
| | | Risk of environmental disaster | 8 | |
| | Economic Factors | High installation cost | 9 | |
| | | War | 3 | |
| | | Harmful* | 7 | |

* Nuclear power plants are evaluated as positive or negative without providing any explanation.

When the data in Table 4 are analyzed, it is remarked that the classroom teacher candidates have justified their metaphors in terms of the positive and negative aspects of nuclear power plants. It can be stated that the classroom teacher candidates created justifications for the negative aspects (f=166) in comparison to positive aspects (f=144) of the nuclear power plants. This is probably due to the fact that environmental education, environmental pollution, the use of resources and sustainability are more significant for classroom teacher candidates. Hence, their perception of the negative aspects of nuclear power plants may come into prominence. While some teacher candidates mention the *"economic growth"* justification more when drawing attention to the benefits of nuclear power plants, the other teacher candidates mention the *"environmental risks"* by drawing attention to the damages. Thus, the controversial (positive/benefits and negative/damages) status of nuclear power plants as a socio-scientific issue has emerged in the justifications mentioned by the classroom teacher candidates.

While classroom teacher candidates mention more the economic growth as the positive aspects of the nuclear energy plants, they have provided the following justifications at most; *"high energy efficiency"*, *"enabling economic growth"*, *"fulfilling energy needs"*. In terms of environmental impacts, 12 teacher candidates mentioned the *"non-carbon emitting"* character of nuclear power plants. Five teacher candidates described nuclear power plants as *"beneficial"* and did not provide any explanation as justification. The example justifications of classroom teacher candidates about the positive aspects of nuclear power plants are presented below.

*"... this is a need for energy production in our country ..." (TC-19)*

*"... although it will be beneficial in every way..." (TC-26)*

*"... it is like the bee producing honey with high power..." (TC-173)*

*"... we can be more powerful in terms of the economy by producing more energy..." (TC-106)*

*"... we can achieve wealth and power when we reach the treasure..." (TC-41)*

*"...the nuclear power plant does not pollute the air, beautifies the environment..." (TC-66)*

*"...we are going to grow when we have the nuclear energy in our country, and we will be stronger as we grow..." (TC-83)*

*"…it is more economical in comparison to other non-economic methods. we can get the energy we require in a short time at reasonable prices." (TC-83)*

*"... enormous energy is released at low cost by the combination or fission of two entities..." (TC-137)*

*"...it is the necessity of this century for not being in need of anything, we cannot get out of date." (TC-63)*

Classroom teacher candidates evaluated the negative aspects of nuclear power plants in terms of the environmental risk at the most and used the following justifications; *"accident/explosion risk"*, *"risk of disease"*, and *"leak risk".* In terms of economic factors, 9 teacher candidates mentioned *"the high installation costs"* while 3 teacher candidates created *"war"* as the justification. Only 7 teacher candidates described the nuclear power plants as *"harmful"* and they didn't provide any justification. The example justifications of classroom teacher candidates about the negative aspects of nuclear power plants are presented below.

*"...the weapon can serve the war." (TC-98)*

*"... it can spread secretly and it may harm humanity..." (TC-3)*

*"... with the slightest accident, people may die..." (TC-156)*

*"...it may poison the people." (TC-90)*

*"... the genetic deterioration continues for years..." (TC-151)*

*"...there may be unpredictable results if there is an earthquake..." (TC-168)*

*"...if you think deeper and more comprehensively, you can observe the damages. (TC-107)*

*"...you may build it with hope, but it may explode and you may harm the environment." (TC-192)*

*"...it may emit too much radiation. if you use it too much like the telephone, it may cause various diseases." (TC-117)*

*"...it is costly at first, it signifies power." (TC-81)*

The word cloud of the metaphors that the classroom teacher candidates created for nuclear power plants is presented in Figure 1.

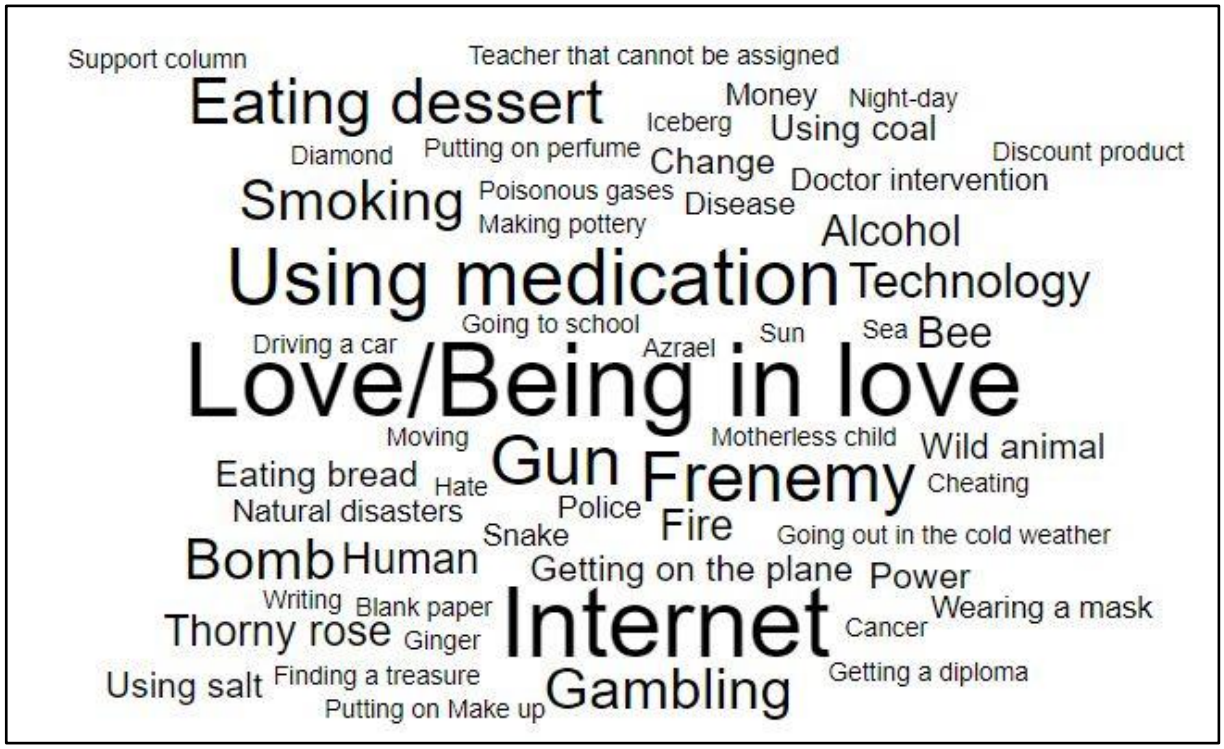


**Figure 1.** Word Cloud for Metaphors Created for Nuclear Power Plant

## CONCLUSION AND DISCUSSION

In this study, the metaphors created by the teacher candidates about nuclear power plants and the justifications of metaphors were ascertained. Teacher candidates created 197 metaphors in 58 different kinds for nuclear power plants and the metaphors used the most are as follows; love/falling in love, internet, getting married, using medication, weapon, frenemy, using phone, bomb, eating dessert, gambling, and smoking. The time period, when teacher candidates experience the metaphors more frequently, the age of the teacher candidates or their environment have been very influential in the creation of the metaphors. According to Yıldızlı et al. (2018), metaphors signify more than words, they facilitate to comprehend the world by including cultural, economic and social factors. The mental images created by metaphors can vary based on the person and factors such as culture, education and environment play a significant role in this difference (Aslan & Filiz, 2018). Consequently, the metaphors that the teacher candidates created such as love, marriage, telephone usage, social media, technology, smoking, etc. highly reflect the inner circle of the teacher candidates.

When the reasons why the classroom teacher candidates use the metaphors are reviewed, it has been concluded that they basically create supportive, opponent and impartial reasons for the nuclear power plants. We have observed that there are many views that oppose nuclear power plants. The literature studies examined; on the establishment of nuclear power plants of University students, they have a negative attitude (Saraf & Basha, 2016), environmental, economic, security, nuclear power plants and biological dimensions of prospective teachers that considers the possible risks because the establishment of this plant have looked negative (Accent & Charles, 2018), class and science teachers because they are against the establishment of nuclear power plants (Sexy, Dey and Dey, 2017), Chernobyl the explosion of the nuclear power plants nuclear power plants adversely affected by thoughts about the (P, Slow & Allen, 2010), as well as conclusions. However, in this study, it was observed that the justifications are very similar and that the classroom teacher candidates perceived the nuclear power plants as a socio-scientific issue and they have realized the contradictory situations. In terms of the production, use, environmental and economic reflections of nuclear energy, class teacher candidates could take beneficial and harmful aspects into consideration. In a study by Turan (2018),

classroom teacher candidates described nuclear power plants as an essential power but drew attention to the damages of the nuclear power plants by creating metaphors such as "bomb". In a study conducted with science teacher candidates, it is comprehended that candidates have a prejudice against nuclear power plants yet they believe that the nuclear power plant is beneficial (Ateş & Saraçoğlu, 2013). In a study on teacher candidates, it was ascertained that almost all of the teacher candidates didn't have sufficient knowledge about nuclear energy, which is highly a socio-scientific subject (Özdemir, 2014). In Sağlam's (2016) study, it has been determined that the number of supporting arguments for the use of nuclear power that the classroom teacher candidates use is highly more than the rebutting arguments. Hence, the study suggested it would be beneficial to include socio-scientific courses in the license program so that the components of the argument can be used more easily. In this study, classroom teacher candidates were able to perceive the issue of nuclear power plants as a socio-scientific issue, and that's because the Environmental Education was based on socio-scientific issues. The environmental education course was presented to teacher candidates in the socio-scientific structure during the academic term and socio-scientific situations related to the society and the environment were discussed in the classroom. In this context, the majority of teacher candidates tend to recognize contradictory situations related to nuclear power plants. This was clearer for the teacher candidates, who are uncertain about nuclear energy and any sided justification cannot be determined in their justifications, by focusing on beneficial/positive and harmful/negative aspects of nuclear energy plants.

Classroom teacher candidates have created justifications based on the positive and negative characteristics of nuclear power plants, and it has been determined that they have more justification for negative characteristics rather than for positive aspects. While teacher candidates, who concentrate on the positive characteristics of nuclear power plants have mentioned justifications primarily about the benefits such as economic growth and fulfilling the energy needs. On the other hand, the teacher candidates, who focus on the negative aspect of nuclear power plants, mentioned mainly the environmental risks such as accident/explosion, disease and leak. In the survey conducted, Yilmaz and Bilge (2018) concluded that the most significant factor affecting the approval of nuclear energy of university students is the benefit of the energy and trust perception while they have mentioned the accidents occurred because of the natural disasters as the major risk factor. In their study, Ateş and Saraçoğlu (2013) found out that if the necessary precautions are not taken, there may be accidents, leakage of radioactive substances and this may cause cancer in the region. However, in the same study, the teacher candidates also asserted the use of nuclear power will minimize the dependence on other countries. In this study, the positive/beneficial and negative/harmful aspects of nuclear power plants have been the very base of the justifications that the classroom teacher candidates used and it has been understood that the teacher candidates were able to perceive the nuclear power plants as a socio-scientific issue.

Since the resources in the world are limited, energy policies along with the developing technology and consumption habits will always be among the indispensable factors of the future. A sustainable environmental education approach should be applied to shape the energy policies that are strictly related to all societies, and societies that have become environmentally conscious need to be formed. It is expected that teachers and teacher candidates, who will teach the environmental awareness to the next generation will have sufficient knowledge about socio-scientific issues that concern the environment. Accordingly, special attention should be given to environmental education to be provided to teacher candidates for enabling sustainable growth and it is necessary to evaluate the situations with its economic and environmental aspects by using a socio-scientific approach. Consequently, it would be possible to raise individuals, who can comprehend the environment, use the resources effectively, produce solutions for the environmental problems they encounter and consider many factors when searching for a solution. In this study, the researcher used the metaphoric teaching approach. It is possible to conduct different studies with different methods and techniques.

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