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Examining preservice teachers' perceptions of the greenhouse effect*

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Abstract

This study aims to determine the perceptions of preservice science, classroom, and social studies teachers regarding the greenhouse effect using metaphors. In line with this purpose, a qualitative research method was employed, and phenomenology was chosen as the research design. The study was conducted in the fall semester of the 2024-2025 academic year with the participation of 76 preservice teachers (55 female, 21 male) who were fourth-year students in the science education, social studies education, and classroom teaching programs at a medium-sized education faculty in the Central Anatolia Region, and who fully completed the information in the data collection tool. The data collection tool used in the study consisted of a form with questions aimed at learning the participants' descriptive information and an open-ended statement. The data obtained in the study were analyzed using the content analysis technique, and similar data were grouped under specific concepts and themes and organized in a way that readers could understand. As a result of the study, it was determined that the preservice teachers created 52 different metaphors, which were grouped under two themes and six categories. Considering the data obtained, it is recommended that primary school and social studies teacher candidates should participate in scientific activities related to the environment and environmental problems.

Keywords: Greenhouse effect, Preservice teacher, Metaphor, Perception

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INTRODUCTION

Human-induced activities such as rapid population growth, industrialization, urbanization, and the unconscious use of natural resources form the basis of today's environmental problems. Global warming is at the forefront of environmental issues threatening living organisms (Aksan & Çelikler, 2013). Gases such as carbon dioxide, nitrogen, and methane found in the atmosphere's composition are called greenhouse gases, and these gases naturally warm the Earth through the greenhouse effect. The excessive warming that occurs with the increase in the proportion of greenhouse gases in the atmosphere is called global warming (Svihla & Linn, 2012). The greenhouse effect is a natural process that regulates the heat balance on Earth and is necessary for life. However, the increase in the accumulation of greenhouse gases due to human activities such as the use of fossil fuels, cement production, improper land use, and deforestation, i.e., the intensified greenhouse effect, disrupts the Earth's energy balance, causing the planet to warm up more. Global warming caused by the greenhouse effect has become more pronounced in recent years, reaching high values (Türkeş, 2001). This unnatural warming threatens the world environmentally, socially, and economically (Papadimitriou, 2004). Global warming leads to problems such as melting glaciers and rising sea levels, increased natural disasters, desertification and forest fires, extinction of species, and increased epidemics (Akın, 2006). The continued increase in environmental problems has necessitated action to solve these issues (Dere & Çinikaya, 2023a). It is stated that the leading cause of these problems is the alteration of the atmospheric structure (greenhouse gas emissions) by humans burning coal, oil, and natural gas (Dere & Çinikaya, 2023b).

Reducing greenhouse gas emissions, the primary cause of global warming, and preventing the resulting environmental problems are possible through individuals taking responsibility and trying to find solutions (Kahraman, 2020). Raising individuals in educational institutions to be conscious and responsible, in other words, effective environmental education, is the most effective way to prevent the greenhouse effect and the problems it will cause (Roth, 1992). Indeed, environmental education contributes to solving environmental issues by raising responsible, conscious, sensitive individuals who make efforts to solve problems (Aksan & Çelikler, 2013). It is stated that it is necessary to identify and improve the inadequacies in the preservice training of teachers, who play an essential role in transferring knowledge and developing awareness in students within environmental education (Khalid, 2001). When the relevant literature is examined, it is observed that studies have been conducted to determine preservice teachers' cognitive structures regarding environmental problems (Durmuş & Sert, 2022; Tecimer-Altınel, Hamalosmanoğlu & Kızılay, 2024) to assess awareness of environmental issues (Karadağ & Acar, 2020), to examine environmental sensitivity, environmental awareness, and environmental problems together (Yılmaz & Zorlutuna, 2024), to determine opinions on environmental issues (Cansaran & Yapıcı, 2020), to assess environmental literacy levels (Robinson & Crowther, 2001), and to determine environmental attitudes (Watson & Halse, 2005; Major, et al., 2017). One of the most essential concepts in environmental education is the greenhouse effect. It is crucial to thoroughly investigate the concept of the greenhouse effect and present recommendations for environmental education. This study examined the concept of the greenhouse effect through metaphors. Metaphors play a significant role in educational studies. Researchers can identify the underlying concepts of complex phenomena and experiences through metaphors and explain how knowledge is interpreted and understood (Bearman et al., 2021; Demmen et al., 2015).

The word metaphor is derived from the Greek words meta (beyond, extreme) and pherein (to carry, to bear) (Levine-Phoebe, 2005). In Turkish, metaphor finds meaning in words such as figure of speech, simile, and allegory (Şahan, 2017). Metaphors are tools that encompass individuals' knowledge, creative thinking skills, and cognitive structures. Through metaphors, the perception of different concepts can be revealed (Ateş & Karatepe, 2013). Metaphors are powerful mental tools that allow individuals to shape any phenomenon in their minds and explain a complex process (Saban, 2008). Metaphors are closely linked to the way of thinking used to make sense of any situation and play an important role in shaping reality (Kendall & Kendall, 1993). Examining the metaphorical perceptions of preservice teachers

regarding the greenhouse effect is essential, as they will assume the responsibility of raising environmentally conscious and sensitive students when they start their profession. Based on this idea, identifying preservice teachers' perceptions, knowledge, and cognitive structures regarding the greenhouse effect through metaphors and presenting suggestions in line with the findings obtained will contribute to training preservice teachers to be better equipped in this subject and future studies on this topic. When relevant research is examined, it is seen that studies have been conducted aiming to examine social studies preservice teachers' perceptions of environmental problems through metaphors (Kaya, 2014), determine university students' perceptions of the concept of global warming through metaphors (Ateş & Karatepe, 2013), examine high school students' metaphorical perceptions of climate change, global warming, and greenhouse effect concepts (Babaoğlan-Özdemir & Babaoğlan, 2022), examine science preservice teachers' perceptions of the concept of global warming through metaphor analysis (Arslan & Zengin, 2016), and examine university students' metaphorical perceptions of the concept of environment (Aydın, 2011). Unlike the relevant literature, this study aims to determine the perceptions of science, classroom, and social studies preservice teachers about the greenhouse effect through metaphors, as they are expected to provide quality environmental education when they become teachers. Within the scope of this aim, answers to the following questions were sought:

1. What metaphors have science, classroom, and social studies preservice teachers produced regarding the greenhouse effect?
2. Under which themes and categories are the metaphors developed by science, classroom, and social studies preservice teachers regarding the concept of the greenhouse effect grouped?

METHOD

Research Design

This qualitative study uses a phenomenological design to examine preservice teachers' metaphorical perceptions of greenhouse gases through the metaphors they produce. The primary purpose of phenomenological research is to determine the experiences, perceptions, or meanings attributed to the phenomenon or concept under investigation (Denzin & Lincoln, 2017). In line with the nature of qualitative research, phenomenological research does not present generalizations about the phenomenon or concept being examined. Still, it provides data that helps us make sense of the phenomenon or concept (Demircioğlu, 2023). Metaphors are used to determine perceptions of phenomena or concepts under consideration.

Study Group

The study group of the research consists of 92 preservice teachers studying in the fourth year of science, primary school teaching, and social studies teaching programs at the education faculty of a state university located in a medium-sized city in the Central Anatolia Region of Turkey. However, a total of 16 preservice teachers who could not produce a metaphor for the research topic or did not write a metaphor explanation, who made a metaphor but could not create a category because there was only one metaphor (Aladağ & Kuzgun, 2015), who did not answer all the questions in the data collection tool (program, gender, and participation in scientific activities related to the environment) were not included in the study. In this way, 76 (55 female, 21 male) preservice teachers were included in the study group. In determining the study sample, the criterion sampling method, one of the purposive sampling methods not based on probability, was used. In this sampling method, the sample consists of individuals who meet predetermined criteria (Canbazoğlu-Bilici, 2019). In this research, preservice teachers in programs that include environmental courses in the curriculum of primary and secondary schools and those in the fourth year of these programs were included in the study group. The study was conducted in the fall semester of the 2024/2025 academic year. Descriptive information about the research group is presented in Table 1.

Table 1. Descriptive Information of The Study's Working Group

Variable	Category		N		%
Department	Pre-Science Teacher Education		26		34.2
	Primary School Teacher Education		28		36.8
	Social Studies Teacher Education		22		30.0
Gender	Female		55		72.4
	Male		21		27.6
Participation in scientific activities such as environmental projects and nature camps	Yes	Pre-Science Teacher Education	20		
		Primary School Teacher Education	14	43	56.6
		Social Studies Teacher Education	9		
	No	Pre-Science Teacher Education	6		
		Primary School Teacher Education	14	33	43.4
		Social Studies Teacher Education	13		
Total			76		100

Data Collection

The study used a form consisting of questions aimed at learning the descriptive information of the study group and an open-ended statement as a data collection tool. The form includes three questions aimed at learning the descriptive information of the study group, such as the programs of the teacher candidates, their gender, and whether they participated in scientific activities related to the environment, such as projects and nature camps. Additionally, in the prepared form, teacher candidates were asked to complete the statement "The greenhouse effect is like ....., because ....." With the word "like" in this statement, participants were asked to establish a connection between the metaphor source and the metaphor subject they produced, while with the expression "because," they were asked to write a justification for the metaphors they produced (Ekici, 2016). The application was explained through an example after informing the participants about metaphorical expression. After distributing the data collection tool to the participants, they were given 30 minutes to respond.

Data Analysis

A content analysis technique was used to analyze the data obtained in the research. Content analysis aims to reach concepts and relationships that can explain the collected data. In content analysis, similar data are brought together under specific ideas and themes, organized, and interpreted in a way that readers can understand (Yıldırım & Şimşek, 2005). The process of analyzing and interpreting the metaphors developed by 76 teacher candidates who fully completed the data collection tool regarding the concept of the greenhouse effect was carried out by changing the order of two stages specified by Ekici (2016). These stages are, respectively, examining the data papers, numbering the data papers from 1 to 92, and teacher candidates are coded as TC (Science teacher candidates TC1...TC29; Primary school teacher candidates TC32...TC62; Social studies teacher candidates TC63....TC92), re-examining and compiling the data papers, eliminating papers unsuitable for evaluation (TC6, TC9, TC25, TC42, TC45, TC55, TC56, TC61, TC64, TC65, TC66, TC68, TC69, TC77, TC84, TC87), identifying metaphors in suitable papers, developing categories, examining metaphors and distributing them into categories, ensuring validity and reliability, calculating the frequencies of obtained codes, interpreting the data, and reporting the research. The formula Miles and Huberman (1994) specified was used to determine the reliability of the study. After two researchers coded the data separately, the calculated reliability value was 86%. Since this calculated value is above 85%, it was considered reliable (Miles & Huberman, 1994). Additionally, to ensure validity, the data analysis process was explained in detail, and examples from teacher candidates' statements were given as direct quotes for each category (Yıldırım & Şimşek, 2005).

Ethical Considerations

Based on application number 2024-312, the Aksaray University Human Research Ethics Committee, in decision numbered E-34183927-020-00001012052, decided that this study was appropriate regarding scientific research ethics on 19/11/2024.

FINDINGS

Regarding the first sub-problem of the research, Table 2 presents the names of the metaphors developed by the preservice teachers for the concept of the greenhouse effect, the number of metaphors they created, and their explanations about these metaphors.

Table 2. Metaphors Developed by Preservice Teachers Regarding the Concept of the Greenhouse Effect

Order	Metaphor Name	f	Order	Metaphor Name	f
1	Blanket	6	**27**	Newborn baby smell	1
2	Stove	6	**28**	A large fireball	1
3	Thermos	4	**29**	Toxic gas	1
4	Mirror	3	**30**	Erosion	1
5	Turning on natural gas in hot weather	3	**31**	Window	1
6	Sauna	3	**32**	Cigarette	1
7	Cancer	3	**33**	Constantly burning fire	1
8	Quilt	2	**34**	Cigarette smoke	1
9	Greenhouse used in agriculture	2	**35**	Heater	1
10	Disease	2	**36**	Water overflowing from a glass	1
11	Shooting oneself in the foot	1	**37**	Car with sunroof	1
12	Terminal cancer patient	1	**38**	Food pyramid	1
13	Matryoshka	1	**39**	Coronavirus	1
14	Boiling food	1	**40**	Member of the household	1
15	Oven	1	**41**	Multiple perfumes sprayed in a closed room	1
16	Thermal insulation	1	**42**	Glass balcony	1
17	Sound insulation	1	**43**	The car under the sun	1
18	Imbalance	1	**44**	Garbage	1
19	Insulation	1	**45**	Flying balloon	1
20	A vehicle with closed windows	1	**46**	Ivy	1
21	Foundation	1	**47**	Absence	1
22	Mousetrap	1	**48**	Prison	1
23	Solar panel	1	**49**	Vacuum	1

24	Glass roof	1	**50**	Bomb	1
25	Vortex	1	**51**	Fire	1
26	Black hole	1	**52**	Bell jar	1

According to Table 2, preservice teachers developed 52 metaphors related to the greenhouse effect and made 76 explanations explaining these metaphors. Among the metaphors produced by the preservice teachers, the blanket metaphor was created by the participants in all three programs: the stove (science and classroom), mirror (classroom and social), quilt (classroom and social), sauna (science and social), cancer (science and social) metaphors were produced by the participants in two programs. The first three most developed metaphors are blanket (f=6), stove (f=6), and thermos (f=4) metaphors, respectively. It is seen that the first three most developed metaphors are generally related to increasing and maintaining temperature. Ten metaphors developed by preservice teachers were repeated between six and two times. The word cloud, which shows the metaphors developed by preservice teachers for the greenhouse effect concept, is presented in Figure 1.

Figure 1. Word Cloud of The Metaphors Developed by Preservice Teachers for the Concept of Greenhouse Effect

The distribution of the number of metaphors developed by preservice teachers about the concept of the greenhouse effect according to the programs they studied is presented in Table 3.

Table 3. Distribution of Metaphors Developed by Preservice Teachers Regarding the Concept of the Greenhouse Effect According to Their Programs.

Department	Number of Metaphors	%
Science Teacher Education	22	37.3
Primary School Teacher Education	22	37.3
Social Studies Teacher Education	15	25.4
Total	59	100

Preservice science and primary school teachers developed 22 metaphors (37.3%) for the greenhouse effect. On the other hand, preservice social studies teachers developed 15 metaphors (25.4%).

As a result of the analysis carried out to answer the second sub-problem of the research, 'Under which themes and categories are the metaphors developed by preservice teachers for the concept of greenhouse effect grouped?', it was determined that the metaphors developed by preservice teachers for the concept of greenhouse effect were grouped under two themes and six categories. The first theme, 'Influencing,' consists of 'Mutual' and 'Harmful.' In contrast, the second theme, 'Regulation,' includes 'Ensuring Balance,' 'Bringing to Ideal Temperature,' 'Taking Precautions,' and 'Holding / Confinement' (Table 4).

Table 4. Themes and Categories of Metaphors Developed by Preservice Teachers regarding the Greenhouse Effect Concept

Theme	Category
Influencing	Mutual
	Harmful
Regulation	Ensuring Balance
	Bringing to Ideal Temperature
	Taking Precautions
	Holding/Confinement

The categories, metaphors, and sample explanations for explaining the metaphors that make up the 'Influencing' theme, which is the first theme formed by the metaphors developed by preservice teachers about the greenhouse effect concept, are summarized in Table 5.

Table 5. Categories, Metaphors, and Example Explanations that Constitute the Influencing Theme.

Theme	Category		Metaphor	f	Example Explanation
Influencing	Mutual	✓	Mirror*	2	*TC63: The greenhouse effect is like a mirror because we must prepare and face it according to what we want to see. For example, preparing to look good.*
		✓	Matryoshka		*TC43: The greenhouse effect is like a matryoshka because actions influence one another. I likened it to a matryoshka because it is interconnected and affects future generations.*

	✓ Shooting oneself in the foot ✓ Imbalance ✓ Turning on natural gas in hot weather ✓ A vehicle with closed windows ✓ Vortex ✓ Black hole ✓ A large fireball ✓ Cancer ✓ Toxic gas ✓ Erosion ✓ Disease* ✓ Cigarette ✓ Constantly burning fire ✓ Quilt* ✓ Cigarette smoke ✓ Water overflowing from a glass ✓ Food pyramid ✓ Coronavirus ✓ Member of the household ✓ Stove* ✓ Multiple perfumes sprayed in a closed room ✓ The car was left under the sun ✓ Ivy ✓ Absence ✓ Fire ✓ Bell jar		
Harmful		26	*TC62: The greenhouse effect is like turning on natural gas in hot weather because it causes excessive, undesirable heating and leads to irreversible illnesses.* *TC29: The greenhouse effect is like cancer because it gradually affects the entire world, rendering it uninhabitable.* *TC21: The greenhouse effect is like the coronavirus because if left unchecked, the greenhouse effect, like a virus, will increase. Problems such as drought will occur.* *TC72: The greenhouse effect is like toxic gas because it leads to global warming and makes our world less habitable.* *TC82: The greenhouse effect is like a cigarette because just as it weakens and consumes a person over time, it also consumes the world.* *TC3: The greenhouse effect is like fire because its intense heat harms the environment.* *TC58: The greenhouse effect is like a vehicle with closed windows because it overheats with sunlight, and the air poisons living beings.* *TC70: The greenhouse effect is like erosion; it causes harm gradually, little by little.*

*Metaphors containing explanations of more than one theme/category

When Table 5 is analyzed, most metaphors in the 'Influencing' theme are found in the 'Harmful' category (f=26; 92.9%). The number of metaphors in the 'Mutual' category, another category, is 2 (7.1%).

The 'Mutual' category under the influence theme is related to influencing each other. When the preservice teachers' explanations about the metaphors in this category are analyzed, they emphasize that the reaction that emerges because of an effect will be affected by the one who creates that reaction. In explaining the metaphors in the 'Harmful' category, the harm of the effect is mentioned.
The second theme formed by the metaphors developed by preservice teachers about the concept of the greenhouse effect is 'Regulation.' The categories forming this theme, metaphors, and sample explanations for explaining metaphors are summarized in Table 6.

Table 6. Categories, Metaphors, and Example Explanations that Constitute the Theme of Regulation.

Theme	Category	Metaphor	f	Example Explanation
Regulation	Ensuring Balance	✓ Boiling Food ✓ Oven ✓ Heater ✓ Blanket* ✓ Newborn Baby Smell	5	*TC50: The greenhouse effect is like boiling food because if it boils enough, the food cooks. However, if you boil it too much or turn up the heat too high, the food spoils and you cannot eat it.* *TC47: The greenhouse effect is like an oven because the more you heat, the more the food burns. If the temperature is set to medium, there is no harm.* *TC83: The greenhouse effect is like the smell of a newborn baby because it is pure white, and purity makes us happy.*
	Bringing to Ideal Temperature	✓ Mirror* ✓ Quilt* ✓ Stove* ✓ Sauna* ✓ Blanket* ✓ Car with Sunroof ✓ Glass Balcony	7	*TC31: The greenhouse effect is like a mirror; it reflects the heat from the sun to the Earth.* *TC73: The greenhouse effect is like a blanket because it warms the Earth.* *TC1: The greenhouse effect is like a car with a sunroof because light rays from the sunroof increase the temperature inside the vehicle.*
	Taking Precautions	✓ Terminal Cancer Patient ✓ Disease* ✓ Bomb	3	*TC53: The greenhouse effect is like that of a terminal cancer patient because reversing it is possible but difficult. Early intervention saves lives.* *TC4: The greenhouse effect is like a bomb because if precautions are not taken early, it is the end for the Earth and living beings.*

Holding/Confinement	✓ Thermal Insulation ✓ Blanket* ✓ Stove* ✓ Sound Insulation ✓ Insulation ✓ Foundation ✓ Mousetrap ✓ Solar Panel ✓ Glass Roof ✓ Greenhouse Used in Agriculture ✓ Sauna* ✓ Thermos ✓ Window ✓ Garbage ✓ Flying Balloon ✓ Prison ✓ Vacuum	17	*TC71: The greenhouse effect is like a thermos because it traps heat.* *TC76: The greenhouse effect is like a blanket because when life energies like sunlight and heat come to Earth, this blanket traps them inside.* *TC51: The greenhouse effect is like a stove because the hot air from the furnace, instead of spreading throughout the house, is trapped in one room, just like in a greenhouse.* *TC28: The greenhouse effect is like a prison because you cannot leave once you enter.* *TC49: The greenhouse effect is like a greenhouse used in agriculture because greenhouses are covered. Since it is covered, the heat stays inside. When it is open, no heat accumulation is observed.*

*Metaphors containing explanations of more than one theme/category

According to Table 6, 17 (53.1%) metaphors are in the 'Holding / Confinement' category, 7 (21.9%) in the 'Bringing to Ideal Temperature' category, 5 (15.6%) in the 'Ensuring Balance' category, and 3 (9.4%) in the 'Taking Precautions' category in the 'Regulation' theme.
The metaphor explanations in the 'Ensuring Balance' category focus on regulation, balance, and happiness caused by balance. The metaphor explanations in the 'Bringing to Ideal Temperature' category focus on ensuring the ideal temperature. The metaphor explanations in the 'Taking Precautions' category mention precaution, and the metaphor explanations in the 'Holding / Confinement' category mention preservation.

DISCUSSION and RECOMMENDATIONS

In the study, which aimed to determine preservice teachers' perceptions of the greenhouse effect through metaphors, it was determined that preservice teachers developed 52 metaphors related to the concept of the greenhouse effect. The frequency of use of these metaphors is 76. While the 10 metaphors developed were repeated between two and six times, the first three metaphors developed the most were blanket, stove, and thermos (Table 2). Like this finding, at the end of the study conducted by Kaya (2013), aiming to determine the metaphor perceptions of preservice social studies teachers towards the concept of global warming, it was determined that the second most developed metaphor of preservice teachers about the idea of global warming was the stove. The fact that these three metaphors, which were developed the most by the preservice teachers, are concepts related to temperature increase and temperature maintenance shows that the preservice teachers perceive the

greenhouse effect as a mechanism that ensures that the temperature of the Earth is increased to an appropriate degree and kept at an ideal value. The greenhouse effect is an essential factor that prevents heat from escaping from the atmosphere and keeps the Earth warm. Without the greenhouse effect, the average global temperature would be lower, and life would become impossible (Damayanti, Efwinda & Junus, 2023).

While preservice science and primary school teachers developed 22 metaphors about the greenhouse effect, prospective social studies teachers developed 15 (Table 3). Yanarateş and Yılmaz (2020), at the end of the study in which they aimed to determine the metaphorical perceptions of preservice teachers studying in the departments of science, social studies, and classroom teaching about the concept of environmental awareness, stated that the most metaphors were developed by preservice teachers studying in the department of classroom teaching and the least metaphors were developed by preservice teachers studying in the department of social studies teaching. It is thought that participation in scientific activities such as projects and nature camps related to the environment is effective in the emergence of such a result. According to Table 1, preservice social studies teachers were the group that participated the least in scientific activities related to the environment. In a study conducted by Balkan Kıyıcı, Atabek Yiğit, and Selcen Darçın (2014), the effect of nature education carried out within the scope of an environmental project supported by TUBITAK on the change in environmental literacy levels of preservice teachers and their views on nature education was examined. At the end of the study, it was concluded that nature education significantly increased the environmental perception dimension of preservice teachers' environmental literacy. In addition, preservice teachers stated that nature education provided environmental awareness, improved their professional development, and allowed them to see the application of theoretical knowledge.

The metaphors developed by preservice teachers are categorized under two themes: 'Influencing' and 'Regulation.' The influencing theme consists of mutual and harmful categories, while the regulation theme includes four categories: ensuring balance, bringing to the ideal temperature, taking precautions, and holding/confinement (Table 4). As a result of the general evaluation, it was seen that the preservice teachers emphasized in influencing theme that the greenhouse effect may increase as a result of human activities and that human beings will be affected by this increase, that the greenhouse effect is a mechanism that provides vitality on Earth, but that the increasing greenhouse effect will cause negativities for living things. The highest number of metaphors under the theme of influence was found in the harmful category (Table 5). From this point of view, it is thought that preservice teachers consider the issue of global warming caused by the increase in the greenhouse effect significant.

From the metaphor explanations in the regulation theme, it is understood that the preservice teachers mentioned that the temperature is balanced with the greenhouse effect; greenhouse gases retain the sun rays reflected by hitting the Earth. Thus, the ideal temperature is provided for living things, which makes the Earth habitable. If no measures are taken, excessive temperature increases will harm life on Earth. In the regulation theme, most metaphors are holding/confinement (Table 6). Therefore, preservice teachers know the mechanism of the greenhouse effect, which is realized in the form of the sun rays reflected from the Earth being captured by greenhouse gases and reflected to the world.

According to the themes and categories formed by the metaphors developed by preservice science, primary school, and social studies teachers, it can be stated that preservice teachers' perceptions of the greenhouse effect are positive. Similar to this result, Coşkun and Aydın (2011), in their study aiming to determine the perceptions of 161 prospective geography teachers about the greenhouse effect, stated that most prospective teachers answered the questions about defining the concept of the greenhouse effect correctly. Still, they had some misconceptions about the causes, consequences, and precautions that could be taken. At the end of the study conducted by Aksan and Çelikler (2015) with 4th-grade students of elementary mathematics, science, social sciences, classroom, and preschool teaching, it was

stated that preservice teachers were aware of the global warming problem caused by the increase in the greenhouse effect and were concerned about the consequences of this problem and that they had sufficient perception. However, they had some misconceptions about the prevention of this problem. It is thought that this result is significant in showing the quality of environmental education to be given by preservice teachers who will provide environmental education when they become teachers. As stated by Efwinda et al. (2024), preservice teachers, who are the teachers of the future, must first perceive the subjects they will teach to their students correctly.

The following suggestions can be developed in the light of the findings obtained at the end of the study, aiming to determine the perceptions of preservice teachers studying in the 4th grade of science, primary school, and social studies teaching about the greenhouse effect concept through metaphors:
1. Primary school and social sciences teacher candidates can ensure participation in scientific activities such as projects and nature education related to environmental issues.
2. The study was conducted with preservice science, primary school, and social studies teachers who will provide environmental education in primary and secondary schools. Similar analyses can be performed with preservice teachers who will provide environmental education in high schools.
3. Similar studies can be conducted with current teachers.

Statement of Researchers

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