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Perceptions of Pre-Service Science Teachers in Nusantara Capital City About The Greenhouse Effect

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Abstract

The Greenhouse Effect is essential in protecting the survival of living things on Earth. However, the system will crash if the Greenhouse Effect is excessive. The form of damage is global warming which can cause system changes to ecosystems on Earth. A group that can take a proactive role in this educational context is the student community. This study aims to provide an overview of preservice science teachers' perception of the Greenhouse Effect and understanding of the environment, especially in the Nusantara capital city. The research method used an exploratory study with a quantitative and qualitative approach. The data collection technique used a survey using a questionnaire instrument to students of Physics, Biology, Chemistry, and Geography Education at Mulawarman University. The questionnaire in this study used was developed by Boyes and Stanisstret (1993). The questionnaire consisted of 36 statements rated on a 3-point Likert scale. The statement was divided into three sections, each containing 12 statements, distributed using Google Forms. The results showed that preservice science teachers had many misperceptions and were still wrong in determining the cause-and-effect relationship of the greenhouse effect and solutions to reduce it.

1. INTRODUCTION

Learning science is closely related to scientific concepts; understanding concepts is the most crucial aspect of science learning activities. This understanding is to avoid misconceptions in students and is one of the conditions for achieving success in learning science (Dewi & Ibrahim, 2019). Education is, therefore, a critical factor in debunking misconceptions about global warming because humans are an essential component that should be considered in science teaching to improve human attitudes toward environmental sustainability (Meilinda et al., 2017).

During this period, environmental problems are associated with water, air, and soil pollution, especially in industrial sites. Industrialization brings different hazardous ecological issues, such as ozone layer depletion, an increase in the greenhouse effect, global warming, and degradation of some natural resources. The greenhouse effect has been a topic of discussion recently, even though it is discovered recently (Shepardson et al., 2011; Etoboro, 2020; Oktyabrskiy, 2019). Education can be used to mitigate global warming problems (Efwinda et al., 2022). However, other research shows that science teachers and students are misinformed about the causes of global warming, the problems it poses, the ozone layer, and mitigating the harmful effects of current climate phenomena (Aksan & Celikler, 2013; Cimer, Cimer & Ursavas, 2011; Cardak & Dikmenli, 2016; Khalid, 2003; Pekel & Ozay, 2005; Jafer, 2020).

The Greenhouse effect is a leading factor in keeping the Earth warm because it keeps some of the planet's heat that would otherwise escape from the atmosphere out to space. Without the greenhouse effect, the Earth's average global temperature would be much colder, and life on Earth as we know it would be impossible. Greenhouse gases include water vapour, CO_2, methane, nitrous oxide (N_2O), and other gases. Carbon dioxide (CO_2) and other greenhouse gases turn like a blanket, gripping Infra-Red radiation and preventing it from escaping into space. Later, warming the atmosphere's lower layers due to the accumulation of greenhouse gases increased the surface temperature. As a result, temperatures become higher than they should be, leading to irreversible consequences, such as climate change and global warming (Kweku et al., 2018; Huang et al., 2016).

In addition, global climate change is also an essential issue at the current time. This issue has led to a gradual increase in global average annual temperature starting with the industrial revolution in the early 20th century. Extreme weather events in recent years have intensified the debate about rising global temperatures. High levels of manufacturing and economic activity, including emissions of major greenhouse gases, such as carbon dioxide and methane, explain temperature changes (Albergel et al., 2010). Air is an essential factor in life and living. However, in this modern era, in accordance with the development of physical development of cities and industrial centers, and the development of transportation as a result of technology, air quality is also experiencing changes caused by air pollution or as a form of changing one of the air compositions from normal conditions, namely the influx of pollutant substances (in the form of gases and aerosol particles) into the air in a certain amount for a sufficiently long period so that they can interfere with the life of humans, animals, and plants (Ami & Damayanti, 2021). Therefore, researchers have focused on how students as preservice science teachers respond to the greenhouse effect, the factors that cause it, the consequences it causes, and the solutions provided to reduce the greenhouse effect. The greenhouse effect has been discussed a lot recently, even though it has been discovered for a long time.

Related to the greenhouse effect with the development of the IKN area, the government plans to move the capital city to East Kalimantan Island starting in 2022. The development of the Nusantara capital city (IKN) plan has been considered the basic principles of the environment according to the recommendations of Strategic Environmental Assessment from the Ministry of Environment and Forestry in 2019. In addition, one concept used as a reference is the Forest City. The development of IKN is directed at minimizing damage to natural ecosystems, restoring forest ecosystems, providing green corridors, reducing greenhouse gas emissions, managing water resources in a holistic, integrated manner, maintaining water quantity and quality, implementing controlled area development that protects ecosystems and environmental quality and community involvement in the use and preservation of nature (Mayasari, 2022; Hutasoit, 2019). In accordance with the agenda for building Indonesia's new capital city in Kalimantan, human resources in the education sector are required to respond. One of the

state government agencies in Kalimantan that have produced the nation's next generation in the field of education is Mulawarman University, so the population used in this study comes from that institution.

Essentially, this study determines the perceptions of preservice science teachers in the Nusantara Capital City about the greenhouse effect and their misconceptions. The results of this study are expected to provide helpful information to correct misconceptions that future preservice science teachers acquired about the greenhouse effect.

2. METHOD

This study was an exploratory study conducted to investigate the self-perceptions of science teacher trainees about the greenhouse effect in the Nusantara capital city. The research was carried out in June and July 2022 at the Faculty of Education and Culture, Mulawarman University, Department of Mathematics and Natural Sciences, namely Study Program of Physics Education, Biology Education, Chemistry Education, and Geography Education. The participants were students of the Study Program of Physics Education, Biology Education, Chemistry Education, and Geography Education at Mulawarman University, where they received material related to the greenhouse effect.

The data collection technique used a survey technique using a questionnaire instrument. The research instrument used was a questionnaire developed by Boyes and Stanisstret (1993) and adapted from Jafer (2020) consisting of 36 statements with three answer options, namely "true," "false," and "no idea." These statements were divided into three components: 1) general knowledge about the greenhouse effect, 2) factors that cause or increase the greenhouse effect, and 3) solutions to reduce the greenhouse effect. Table 1 shows the questionnaire items used in the survey.

Table 1. Questionnaire items

General Knowledge About The Greenhouse Effect	**If the greenhouse effect gets bigger…**
	1. The Earth will get hotter
	2. More people will get food poisoning
	3. There will be more flooding
	4. More fish will get poisoned in the rivers
	5. More people will get skin cancer
	6. Some of our tap water will become unsafe to drink
	7. There will be more 'bugs' and 'pests' on crops
	8. There will be changes in the world's weather
	9. More people will die of heart attacks
	10. There will be more deserts in the world
	11. Some of the ice at the North and South Poles will melt
	12. There will be more earthquake
Factors That Cause or Increase The Greenhouse Effect	**The greenhouse effect is made worse…**
	13. By rubbish dumped in rivers and streams
	14. Because too many of the Sun's rays get to the Earth
	15. By too much carbon dioxide in the air
	16. By too much ozone near the ground
	17. By too much litter in the streets
	18. By gas from rotting waste
	19. By radioactive waste from nuclear power stations
	20. By acid in the rain
	21. By CFC gas from spray cans
	22. By gas which comes from artificial fertilisers
	23. By holes in the ozone layer
	24. Because the Sun's rays cannot escape from the Earth

Solutions to Reduce The Greenhouse Effect	The greenhouse effect can be made smaller…
	25. By having more nuclear power stations instead of coal power stations
	26. By eating healthy foods
	29. By reducing the number of nuclear bombs in the world
	30. By planting more trees in the world
	31. By making our electricity from wind, waves, and tides
	32. By using recycled paper more
	33. By protecting rare plants and animals
	34. By not wasting electricity
	35. By reducing starvation in the world
	36. By not using cars so much

Research conducted using the questionnaire method needed to be tested for reliability or level of confidence so that the questionnaire used could be trusted as a data collection tool. This was conducted by validating the content and evaluating the instrument's clarity using the discussion method to review the comments and feedback received, such as minor changes to language translations in the statements made. Jafer's study (2020) results also show that reliability is determined using Cronbach's Alpha and is obtained around 0.922 for the instrument. The questionnaire statements were compiled and distributed with the help of Google Forms. In addition, several general questions were also included related to the greenhouse effect and its relationship with the development of the Nusantara capital city, which participants might know as evidence from the results of written interviews.

3. RESULTS AND DISCUSSION

The number of participants obtained during the distribution, filling out, and collecting the questionnaires was 109 people.

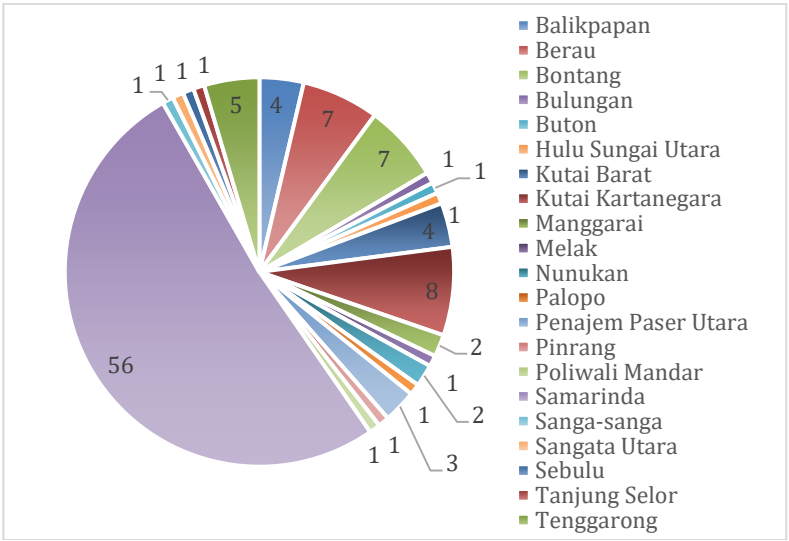

Figure 1. Data Diagram of the Hometown - Preservice Science Teachers

By reviewing the background of these students based on their city of origin (Figure 1), the majority of them come from Samarinda, which in the future can contribute to the field of education, especially in IKN.

Based on the results of written interviews regarding where the information about the Greenhouse Effect they obtained originated from schools (86.20%), social media (73.4%), universities (67.9%), and television news (65.1%) followed by other sources as shown in

Figure 2. This proves that most students receive information on the Greenhouse Effect from the school environment, social media, and television news.

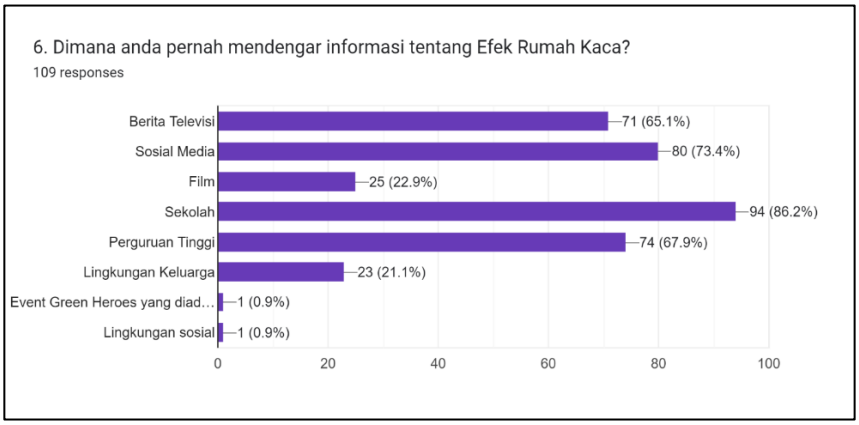

Figure 2. Where to Obtain the Source of Information Related to the Greenhouse Effect

Quantitative Analysis Results

The results of the frequency distribution (f) and percent (%) of the responses of preservice science teachers to the 36 questionnaire items were divided into three components: 1) general knowledge about the greenhouse effect, 2) factors that cause or increase the greenhouse effect, and 3) solutions to reduce the greenhouse effect.

1) General Knowledge About The Greenhouse Effect

The data presented in Table 2 shows the statement items in terms of general knowledge about the greenhouse effect and the results of the responses of preservice science teachers. As displayed in the data (statement 1), all participants agree (100%) that the greenhouse effect can impact global warming. This is also supported by the majority of their opinions (84.26%) that the greenhouse effect can cause more severe flooding (statement 3), (96.30%) weather changes (statement 8), and some polar ice. North and South will melt (statement 11) with the same vote (95.37%). Then, some participants agree (44.44%) that the greenhouse effect might also cause an increase in insects and pests on plants (statement 7), and more deserts would appear in the world (statement 10) in their opinion (54.63%).

Table 2. Results of Participant Responses About The Increasing Greenhouse Effect

Items	True		False		No idea	
	f	%	f	%	f	%
1	109	100.00	0	0	0	0
2	51	47.22	33	30.56	25	23.15
3	91	84.26	13	12.04	5	4.63
4	64	59.26	22	20.37	23	21.30
5	92	85.19	5	4.63	12	11.11
6	79	73.15	13	12.04	17	15.74
7	48	44.44	24	22.22	37	34.26
8	104	96.30	0	0	5	4.63
9	28	25.93	39	36.11	42	38.89
10	59	54.63	24	22.22	26	24.07
11	104	96.30	1	0.93	4	3.70
12	31	28.70	38	35.19	40	37.04

However, further examination of the other statements revealed that some participants' responses misunderstood the points related to the greenhouse effect because they

mistakenly believe that (47.22%) of the greenhouse effect will have an impact on food poisoning (statement 2), (59.26%) of poisoned fish in the river (statement 4), (85.19%) experience skin cancer (statement 5), (73.15%) tap water that is not safe to drink (statement 6), (25.93%) many people die from heart attacks (statement 9), and (28.70%) many earthquakes occur (statement 12).

2) Factors That Cause or Increase The Greenhouse Effect

Table 3 shows the information on the results of the responses of preservice science teachers regarding factors that can increase the greenhouse effect. Most participants agreed (70.37%) that the emergence of gas from decomposing waste (statement 18) was the cause. Slightly different percentages of response results obtained from several participants (61.11%) showed that carbon dioxide in the air (statement 15) (78.70%) increased CFCs in the atmosphere (statement 21) and gases originating from artificial fertilizers (statement 22) was also part of the factors that cause the greenhouse effect (59.26%).

Table 3. Results of Participant Responses About Factors That Cause/Increase The Greenhouse Effect

Items	True		False		No idea	
	f	%	f	%	f	%
13	66	61.11	25	23.15	18	16.67
14	76	70.37	20	18.52	13	12.04
15	67	62.04	18	16.67	24	22.22
16	51	47.22	33	30.56	25	23.15
17	49	45.37	46	42.59	14	12.96
18	77	71.30	18	16.67	14	12.96
19	82	75.93	11	10.19	16	14.81
20	77	71.30	16	14.81	16	14.81
21	85	78.70	7	6.48	17	15.74
22	65	60.19	25	23.15	19	17.59
23	93	86.11	8	7.41	8	7.41
24	86	79.63	9	8.33	14	12.96

Compared with the other statements, most of the responses from preservice science teachers believed more in the factors that affect the greenhouse effect with wrong perceptions. For example, (61.11%) of the waste that was thrown into the river (statement 13) or on the streets (statement 17), turned out that the items in the statement had different response values. Even though the statement have the same meaning, there is only a slight difference in place. Especially in statement 17, there were almost the same two parts with correct responses (45.37%) and wrong responses (41.67%). Furthermore, most of them agreed (70.37%) if the sunlight reached the Earth (statement 14), then (79.63%) it was exacerbated by the sunlight not being able to get out of the Earth (statement 24), (47.22%) too much ozone near land (statement 16), (86.11%) the appearance of a hole in the ozone layer (statement 23), (75.93%) the presence of radioactive waste from nuclear power plants (statement 19), and (71.30%) acid rain (statement 20). Although, the points of the statement showed the effects of the greenhouse effect.

3) Solutions to reduce the Greenhouse Effect

Based on the results of the responses of preservice science teachers regarding the factors that can reduce the greenhouse effect (Table 4), most of them agreed more in showing the solution, namely (97.22%) how to plant more trees in the world (statement 30), (71.30%) used wind, water, and waves (tidal) as a source of electric power (statement 31), (46.30%) the use of nuclear power plants as a substitute for coal-fired power plants

(statement 25), (74.07%) used more recycled paper (statement 32), (75%) saved electricity (statement 34), and (85.19%) decreased use of cars (statement 36).

Table 4. Results of Participant Responses About Reducing The Greenhouse Effect

Items	True		False		No idea	
	f	%	f	%	f	%
25	50	46.30	19	17.59	40	37.04
26	43	39.81	40	37.04	26	24.07
27	63	58.33	20	18.52	26	24.07
28	69	63.89	11	10.19	29	26.85
29	56	51.85	14	12.96	39	36.11
30	106	98.15	1	0.93	2	1.85
31	77	71.30	11	10.19	21	19.44
32	80	74.07	11	10.19	18	16.67
33	59	54.63	26	24.07	24	22.22
34	81	75.00	17	15.74	11	10.19
35	25	23.15	56	51.85	28	25.93
36	93	86.11	8	7.41	8	7.41

Meanwhile, when viewed with other statements, the responses from some participants are misunderstandings in providing solutions to the greenhouse effect, such as (39.81%) eating healthy food (statement 26), (58.33%) keeping the beach clean (statement 27), (62.96%) unleaded gasoline (statement 28), reduce the number of nuclear bombs in the world (statement 29), and (54.63%) protecting rare plants and animals (statement 33). However, this is different from one of the statements that they can answer correctly, namely, according to their response (50.93%), that reducing world hunger is not a solution to reducing the greenhouse effect (statement 35).

Qualitative Analysis Results

In the research, we attached several written questions to preservice teachers to ask for answers, such as " *Please write your comments about the Greenhouse Effect*. " In general, the analysis results of the responses of preservice science teachers who answered these questions are as follows:

> "*The greenhouse effect is a phenomenon in which sunlight enters through the earth's atmosphere but cannot go out again into space, but is reflected by the gases in the atmosphere to the earth's surface again.*"
>
> "*The greenhouse effect occurs due to the depletion of the ozone layer in the atmosphere, so that heat that enters through the atmosphere is reflected, causing global warming.*"
>
> "*The greenhouse effect is the term used to describe the Earth experiencing a greenhouse effect above where the Earth's atmosphere traps the Sun's heat. Gases in the atmosphere, such as carbon dioxide (CO_2), can retain the Sun's heat so that the Sun's heat is trapped in the Earth's atmosphere.*
>
> "*The greenhouse effect is the entry of radiation from sunlight, and then the radiation is trapped due to the greenhouse effect and raises the Earth's temperature.*"

Meanwhile, the questionnaire also included a question related to preservice science teachers' views on the development of the IKN, such as "*In your opinion, will moving the Nusantara Capital City to East Kalimantan increase the Greenhouse Effect in the region? Explain the reason for your answer*". The goal is to search for what they think about the Greenhouse Effect. The results of the analysis of the responses of preservice teachers who answered these questions, in general, are as follows:

> *"I think it can increase the greenhouse effect because when people occupy the area, they will do illegal logging. The population will increase rapidly and may increase the risk of peatland fires in the area. This is due to climate change, making the new capital city more vulnerable to smoke from forest and land fires, which are likely to last for months, and this can increase the greenhouse effect."*
>
> *"Depending on how the concept of urban planning for the nation's capital will be built, it is clear that it must pay attention to the condition of flora and fauna in the local environment. Even if there is an increase in the greenhouse effect, it is hoped that it will still be below the danger threshold."*
>
> *"Yes, the potential is huge. Even if it is made according to the existing concept, the increase in the greenhouse effect can be minimized. However, it will still be higher than before because the number of vehicles and factories will be higher, which will cause high pollution, and the forest area will be much smaller. Unless the government and the community carry out more environmentally friendly projects and can deal with the greenhouse effect properly."*
>
> *"In my opinion, relocating the national capital to East Kalimantan can increase the greenhouse effect because land clearing for the construction of the capital will result in cutting down forests in East Kalimantan so that the function of forests (trees) as a binder for carbon dioxide gas will disappear and cause the gas to damage the Earth's atmosphere. Even though there will be reforestation to replace the trees that have been cut down, it will take quite a long time."*

The background of all participants comes from the region of Nusantara Capital, the new capital of Indonesia in East Kalimantan Province, with the majority domiciled in the Capital City of Samarinda. If we review the first source of information they receive about the Greenhouse Effect, that is from school. This shows that the information in the form of education that they believe starts from the school environment. Furthermore, the second source of information they receive is through social media. The use of social media now seems to have become commonplace among everyone, especially young people. Especially today, education prioritizes using gadgets rather than reading books. Third, television news is still their choice in obtaining information. Not only broadcasts entertainment, but television also broadcast information or knowledge. This is good because it can add to people's insight and knowledge when watching it. Lastly, universities occupy the fourth position as one of the sources of information they obtain about the Greenhouse Effect. Because it is supposed to be a university as an educational institution, it must be able to meet the scientific standards required in the present and the future. Based on the questionnaire results, all participants have the same perception regarding the increase in the Greenhouse Effect, which will support the Earth's condition to become hotter, often referred to as global warming.

In a literature review, climate change: A Summary of the Science by Pethica (2010) explains the effect of the Greenhouse Effect, which can increase Earth's temperature with heat trapped in the atmosphere. This makes the temperature on Earth higher than direct heating by the Sun as the only source of heat. This problem can also cause desertification, and the climate on Earth changes due to an increase in the Greenhouse Effect, which can cause some ice in the North and South Poles to melt and cause flooding in some areas. Regarding the problem of flooding, Samarinda city is a flood-prone area. The cause of flooding in Samarinda City is due to excess surface runoff, and the runoff is not accommodated in the river body, so the water overflows (Sulaiman, et al., 2020). However, from the results of the written interviews, none of the preservice science teachers respond to the problem that flooding can increase the greenhouse effect in the region of Nusantara capital. Rivers are a significant source of greenhouse gas emissions, with aquatic systems,

such as rivers and lakes, contributing more than half a percent of methane gas in the atmosphere. The reason is that rivers absorb large amounts of carbon and nitrogen from the landscape; all river water contains three greenhouse gases: carbon dioxide, methane, and nitrous oxide.

Interestingly, the results of this study also show that participants understand that insects and pests can attack plants due to an increase in the Greenhouse Effect. This is because climate change due to increasing levels of greenhouse gases in the Earth's atmosphere can significantly impact the development, distribution, and population density of agricultural insect pests. These results are relevant to a study by Jafer (2020).

In addition to the results of other questionnaires, it turns out that preservice science teachers are more in agreement that an increase in the greenhouse effect can cause skin cancer. However, increasing the greenhouse effect and its impact on skin cancer has become a common misconception. The results of this study are consistent with others (Jafer, 2020; Darçın, et al., 2016). Then another misunderstanding, they believe that the greenhouse effect can cause tap water unsafe for consumption. Then the greenhouse effect impacts food poisoning, fish poisoning in rivers, deaths from heart attacks, and earthquakes, so these results are considered wrong perceptions.

In the question about the factors causing the Greenhouse Effect, according to the preservice science teacher, the Greenhouse Effect is exacerbated when there is an increase in the amount of carbon dioxide in the air and from gases released from decaying waste and artificial fertilizers. Because the use of synthetic fertilizers (N), such as urea, and the incorporation of plant residues into the soil results in emissions of nitrous oxide (N_2O). Likewise, the application of urea and lime in soil results in carbon dioxide (CO_2) emissions (Tongwane, 2016). In addition, preservice science teachers also know the facts about the use of aerosol sprays containing CFCs. The results of this study are similar to those obtained by Aksan & Celikler (2013).

Meanwhile, most preservice science teachers mistakenly believe that the greenhouse effect is exacerbated by garbage dumping into rivers and streets. They do not seem to understand whether the garbage left in rivers and streets contributes to the greenhouse effect. They also misunderstand that the greenhouse effect is affected by the amount of sunlight that reaches the Earth. However, they do not realize that the capture of sunlight strengthens the greenhouse effect (Jafer, 2020). In addition, most preservice science teachers think that too much ozone and the appearance of a hole in the ozone layer can cause a greenhouse effect. The function of the ozone layer in the atmosphere is to protect the Earth from the Sun's ultraviolet radiation. When the ozone layer is depleted, it becomes dangerous for humans. Based on written interviews, the results of this statement make them mistaken that the cause of the greenhouse effect occurs because of the hole in the ozone layer. The results of other relevant studies (Aksan & Celikler, 2013; Jafer, 2020; Cardak & Dikmenli, 2016; Etobro, 2020) also reached the same conclusion supporting the results of this study. Another misconception is that they believe the greenhouse effect can be exacerbated by radioactive waste from nuclear stations. Nuclear power generation systems, such as fast breeder reactors (FBR) have been proven to be the most environmentally friendly option (with minimal greenhouse gas emissions and minimal quartile variation) among the other six types of nuclear power generation systems in a study by Kadiyala, Kommalapati, & Huque (2016).

The study results showed that preservice science teachers can understand some solutions to reduce the Greenhouse Effect. This result is evidenced by their agreement on how to grow more plants and trees and then use more recycled paper. In addition, they know that there are other alternatives as sources of electricity, such as wind, water, and sea waves (tides). Reducing the lifestyle of not using a car and saving electricity as a form of awareness encouragement is also their choice. Furthermore, on the other hand, they seem

wrong in providing their responses, such as healthy food, protecting the beach, using unleaded gasoline, reducing the number of nuclear bombs, and protecting plants and animals is not a solution to reduce the greenhouse effect.

4. CONCLUSION

Based on the research results, it can be concluded that preservice science teachers still experience many misperceptions. For example, the impact of the greenhouse effect, many preservice science teachers mistakenly believe that the greenhouse effect will impact the poisoning of food and fish in the river. In terms of causes, many of them are wrong that it is caused by the waste thrown into the river or on the streets. In the aspect of solutions to minimize the increase in the greenhouse effect, a misperception occurs in the solution that keeping the beach clean, unleaded gasoline, reduce the number of nuclear bombs in the world can minimize the increase in the greenhouse effect. The results of this study indicate that most preservice science teachers are still wrong in determining the cause-and-effect relationship of the greenhouse effect and solutions to reduce it. It is necessary to take a big step in overturning common sense regarding the environment in the curriculum of any department to remove some misconceptions from the research results obtained. In addition, regarding the issue of moving the national capital, preservice science teachers think that relocating the national capital will have the potential to cause an increase in the greenhouse effect because population, industry, and development will increase. The ecology of flora and fauna around the area will also be disrupted.

Disseminating information on environmental issues, such as global warming through the mass media has become indispensable. The mass media must become tools that combine scientific research on topics and possible solutions and make them available to the general public in a readily understandable way. In addition, teacher education institutions need to be a trusted source of information and correct misperceptions from the mass media that preservice science teachers may experience. Preservice science teachers need to have good content knowledge as one of the basic knowledge in teaching (Efwinda & Mannan 2021).

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