



THE PERCEPTIONS OF PRE-SERVICE SCIENCE TEACHERS AND SCIENCE TEACHERS ABOUT CLIMATE CHANGE

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ABSTRACT

The global climate phenomenon in the context of climate change is the impact of both the dynamic complex climate system and human behaviors that affect environmental sustainability. Human is an important component that should be considered in science teaching that is believed to improve human attitudes towards the environmental sustainability. The research aims to investigate the perceptions of pre-service science teachers and science teachers in South Sumatra who teach climate change and global warming. The data were collected from 17 science teachers and 53 pre-service science teachers from April to August 2016. The instruments were 17 modified questions which were developed from Pruneau's framework. There are three linear perceptions regarding climate change. First, greenhouse effect causes global warming and global warming causes climate change. Second, ozone leakage causes global warming and global warming causes acid rain. Third, greenhouse effect causes ozone leakage and ozone leakage causes global warming; then it causes climate change and other climatic phenomena. Both pre-service science teachers and science teachers argue that climate change is caused by global warming. Actually, climate change is not only global warming but also global cooling. Those phenomena occur because of interactions among climate system components. They do not believe that education is able to change human attitudes in saving environmental sustainability from global climate change disasters. They believe that media give stronger effects than teachers in shaping those perceptions. Factually, most of wrong perceptions come from media.

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Keywords: global warming; climate change; perception

INTRODUCTION

Education has a positive impact on students' attitudes; one of them is attitude towards the environment. The most important issue of the environment is climate change. Because of that, it becomes part of climate literacy education for all ages, especially for K-16 and adults (Nam & Ito, 2011). In Indonesia, environmental materials such as global warming and climate change are in integrated science classes (at lower secondary schools) and separated science classes (at upper

secondary schools) in different portions and purposes.

Climate change is an important issue because it has a great deal of impacts on the environment, human health, crop productivity, even extinction of the world's living population. However, some people believe that climate change has no impacts on their lives (Pruneau et al., 2001). They believe that humans will be able to survive and adapt from global warming and climate change if they have technology (Shepardson et al., 2012; Tran et al., 2010; Porter et al., 2012). The results of academic surveys in the United States show that people do not reduce their activities of using motor vehicles, air condi-

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tioning, and heating in excess although many of them are concerned about climate change (Nam & Ito, 2011; Leiserowitz, 2006). Indonesia is one of the top four countries that contribute to environmental damage after Brazil, USA, and China (Bradshaw et al., 2010). The purpose of science education in Indonesia is to show wise and responsible behaviors in daily activities such as using energy economically and not harming the environment. Indonesian behaviors that are inconsistent with the purpose of science education are due to the low level of students' understanding of environmental problems contextually. Students' cognitive understanding is influenced by the structure and distribution of the curriculum, the presentation of learning materials, and the cognitive understanding of teachers and prospective teachers (Widiyanti et al., 2015; Fakhriyah et al., 2017); and students' cognitive understanding of the environment influences students' attitudes towards the environment (Courtenay-Hall & Rogers, 2002; Yunus, & Sanjaya, 2013).

Global warming and climate change have a small portion in KTSP science curriculum for lower secondary schools with regards to the topic of environmental problems and pollution. In 2010, global warming and climate change were discussed more on 32 electronic books for teachers and students of lower secondary schools. The portion of these contents is 37% in the seventh graders' books, 12% in the eighth graders' books, and 86 % in the ninth graders' books. The discussion is spread in several topics such as air pollution, earth processes, technological impacts, and life impacts on the lithosphere. In the 2013 curriculum, the issues of global warming and climate change are in the seventh grade of the lower secondary schools. It is at the basic competence of 3.10, which reads: "describes global warming and its impacts on the ecosystem after discussing the concepts of energy, the interaction of living things, and environmental contamination." Besides, global warming and climate change are part of the fourth core competence for the seventh graders. It is at the basic competence of 4.13, which reads: "presents data and information regarding global warming and gives solution to the previous problem of global warming and climate change." The topics on the previous basic competence are photosynthesis and respiration, heat and temperature changes as well as heat propagation, and humans' interaction with their environment. Those topics will not be linked with global warming and climate change. Factually, students do not realize that climate occurs due to intercomponent interactions on earth, solar, and human sys-

tem. This condition is believed to be the impacts of structure and distribution of curriculum.

Teachers' problem is the lack preparation of environmental knowledge contents and interconnection of those contents with others. When teachers assume environmental destruction as a simple content that is restricted to the context and its solution, they will only deliver it without linking the content with others. It shapes students' perception that environmental destruction content is only a memorization concept. Students do not see the concept as a real and contextual problem that threatens their future lives (Mostafa, 2007).

Related research about students' perceptions of global warming was conducted by Kalo, E. L., & Simatupang Z. (2016) at upper secondary schools in Medan, Indonesia. The result shows that students have low knowledge of global warming (<50%). Before implementing 2010 curriculum, the British council conducted a study on the perception of climate change in Indonesia (Marwan & Sweeny, 2010). Previous research also shows that 42% students and 65 % of teachers agree that climate change is caused by nature and human treatment. They are 2.234 teachers and students of primary and lower secondary schools in four provinces of Indonesia (Yogyakarta, East Java, East Borneo, and Papua). Most of them believe that ozone depletion is a major cause of climate change besides pollution. Both teachers and students believe that climate change could be prevented by planting trees. It decreases global surface temperature. National Development Planning Agency recommends climate change as a content of science education in Indonesia (Triastuti et al., 2009). Unfortunately, climate change is delivered as a separated subject in a variety of subjects, especially science, geography, and local content.

This research presents the perception of science teachers and pre-service science teachers in South Sumatra after collaborating global warming and climate change content into the science curriculum for both lower and upper secondary schools. Their perceptions and understandings will be positively correlated to the concerns, attitudes, and behaviors of the students as golden future leaders.

METHODS

The study involved 17 science teachers in one of the teachers' discussion forums in South Sumatra and 53 students of Mathematics and Natural Sciences Education Faculty at one of uni-

versities in South Sumatera. They were students at the 6th semester. They were selected by using purposive sampling. There were several reasons regarding the sampling selection. First, science teachers of lower secondary schools could teach content with an emphasis on science literacy. Second, students of the 6th semester have taken the human and environmental course and environmental chemistry course. Data were collected from May to July 2016 by using an instrument that was developed from Pruneau et al. (2001). It consisted of 17 questions about global warming and climate change context information sources, the relationship between global warming and climate change, and the causes of climate change based on the climate change theory. The data were analyzed, percented, and interpreted descriptively, then compared with the previous similar results that have been revealed elsewhere.

RESULTS AND DISCUSSION

Information on Global Warming and Climate Change

Based on the questionnaire, some initial data related to the global phenomena of global warming and climate change were found. The data are as follows:

Table 1. Information on Global Warming and Climate Change

Global Phenomena	Pre-Service Teacher (%)	Teachers (%)
Global Warming	100	100
Climate Change	100	100

Table 1 shows that both teachers and pre-service teachers have heard of both climate change and global warming phenomena. Teachers and pre-service teachers (100%) get information about climate change and global warming mostly from mass media such as TV broadcasts, newspapers, magazines and internet, such as blog and Wikipedia (75%). Furthermore, the remaining teachers in the class (51%) get the information from

textbooks, friends, and books (36%, 16%, 6%). The small amount of information obtained from textbooks is estimated because the materials regarding global warming and climate change have just been included formally in the school-based curriculum (Syafri, 2008).

Teachers and pre-service teachers believe that global warming and climate change influence their social life (100%) in the form of hot and erratic weather, health, water difficulty, and even emotional level. There are 45% of pre-service teachers and teachers who started thinking about global warming disasters and climate change events after extreme weather events in their neighborhoods, while some teachers (10%) and pre-service teachers state that they like the current weather conditions.

Teachers and pre-service science teachers believed that climate change and global warming impacted on their social life (100%). They caused weather anomalies, health problems, water difficulty, and even emotional level disorder. There were 45% of teachers and pre-service teachers started thinking about disaster that was caused by climate change and global warming. It was because of the extreme weather that has been occurred. Whereas, 10% teachers and pre-service teachers did not think about this case because they loved the current weather condition. The impact of climate change and global warming is a serious concern among people in 34 countries, but it does not necessarily change their lifestyles (Bedford, 2004). Both of problems are not the daily faced issues like terrorists, health or economic problems, so they affect nothing to people's lifestyles (Krosnick et al., 2006). Lifestyle will change when people have direct experiences or the perception of a disaster (Bord et al., 2000; Helgeson et al., 2012). This can be seen on Figure 1.

This is similar with a research that is conducted by Spence et al. (2011) about the flood that encourage the population of a region in the UK to reduce the energy from fossil fuels in their environment significantly. The fossil fuels combustion produces carbon dioxide.

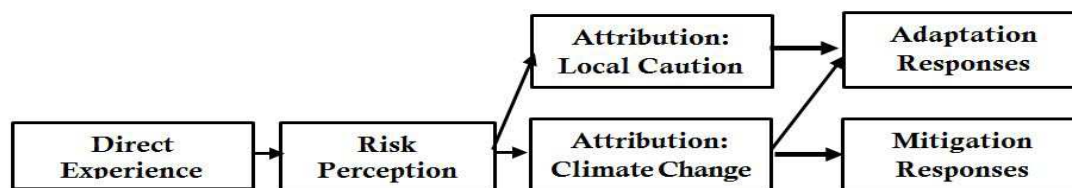


Figure 1. Experience, Perception & Attribution of Risk

Perceptions on The Relationship between Global Warming and Climate Change

Teachers' and pre-service teachers' perceptions on the relationship between global warming and climate change can be seen in Table 2.

Table 2. Perceptions about The Relationship between Global Warming and Climate Change

Teacher	Pre-Service Teacher	%
	Global warming is the cause of climate change.	54
The increasing temperature indicates global warming as climate change increases.	Global Warming and Climate Change cause the effects of Green House Gases and acid rain.	30
	Global warming is tantamount to climate change.	16

All teachers in the sample of this study understand that global warming influences climate change. From further interviews, it is found that teachers equate climate with weather so that climate change is considered as weather change. In other words, the higher the earth's surface temperature gets, the greater the weather changes occur. Weather is defined as the state of the atmosphere in a certain place and time. Weather is usually expressed in terms of temperature, air pressure, humidity, wind speed and direction, rainfall, and turbidity. Meanwhile, climate is defined in terms of average (mean) of weather elements (such as temperature and rainfall) over a period of time (30 years) (Tjasyono, 2006). This perception is also owned by 54% of the pre-service teachers.

According to Table 2, the second pattern of the pre-service teachers is the perception that climate change and global warming are caused by the effects of green house gas and ozone holes. This perception arises because they consider that the dominant green house effect caused by CO₂ arises from human activities. Activities such as forest burning, fossil fuel use, factory smoke and so on produce CO₂, which then binds with ozone in the atmosphere so that the ozone decomposes and punctures. Perforated ozone, according to the perception of the pre-service teachers, can increase the intensity of solar radiation entering the earth's surface so that the temperature increases and then global warming occurs (30%). This perception has three patterns: (A) Green house effect causes global warming, which leads to climate change; (B) The perforated ozone causes global warming and climate change; (C) Green house

effect causes ozone holes and ozone holes cause global warming, and global warming causes climate change and other climatic phenomena.

This perception is similar to what was found in the pre-service teachers and students in America (Khalid, 2003; Daniel et al., 2004) science teachers and students in Turkey (Pekel & A-zay, 2005; Kılınç, 2008), communities in Norway (Ryghaug et al., 2011) and in Canada (Pruneau et al., 2001). Based on further interviews, this perception arises because the students believe that CO₂ will decompose to become C and O₂ in the atmosphere. Carbon from CO₂ will then bind with O₃ in the atmosphere so that O₃ becomes biodegradable and results in ozone perforation. In further interviews, according to the pre-service teachers' perceptions, not only does CO₂ decompose while it is in the atmosphere, but H₂O also becomes H₂ and O. According to them, H₂ and O will regroup into clouds so that it will not disrupt the ozone layer in the atmosphere. Those perceptions arise because students believe that the only cause of global warming and climate change is the CO₂ produced by human activities. Most of these perceptions arise from mass media sources and textbooks in schools (Choi et al., 2010).

Perceptions on The Causes of Climate Change

Climate change based on the existing theory is influenced by several factors such as the movement of continents in geological time, the sun, volcanic eruption, and CO₂ as the impact of human activities (Karl, 2003; Tjasyono, 1986). Based on the data, 100% of teachers and pre-service teachers perceive that humans are the only factor causing climate change. This has led to the answer to the questionnaires about the impact of volcanic eruptions on climate being largely unpredictable weather changes (65% of teachers, 64% of pre-service teachers). Nevertheless, 20% of students admitted that they did not know the effect of volcanic eruptions on climate, while the rest perceived that volcanic eruptions could cause a global rise in the temperature of the earth. According to the pre-service teachers and teachers, the causes of climate change in general are air pollution (72% and 65%) and ozone layer depletion (36% and 35%); and one person perceived that climate change is caused by the rotation of the earth due to the interaction of the earth with the sun.

Volcanic eruption releases lava from the lithosphere inner layer (geosphere). It forms rocks on the surface of the earth as well as spraying particles of gas and dust into the atmosphere layer. The gas and dust entering the atmosphere will

continue to enter the stratosphere and affect the climate system (Solomon et al., 2011). The dust from volcanic eruptions entering the stratosphere will prevent the entry of solar radiation to the earth's surface and will have an impact on global cooling (Rampino et al., 1979). Most teachers and pre-service teachers misunderstand the effects of eruption on climate change because this material does not deliver in junior high school and senior high school even in Biology or Physics education program. This is similar to research findings that was conducted in Canada by Pruneau et al. (2001).

Actions to Climate Change

Based on Table 1, 100% of teachers and pre-service teachers have heard about global warming and climate change. They are worried about the phenomenon, especially after the occurrence of extreme events in their region (81%). According to teachers (41%), the most likely action to slow climate change is to educate people about the importance of caring about issues of global warming and climate change. According to pre-service teachers of chemistry education, the most likely action to slow climate change is by reducing pollution and recycling. Meanwhile, the pre-service teachers majoring in Biology suggest that climate change be slowed by planting trees. This difference is thought to be influenced by their scientific backgrounds. Although teachers and pre-service teachers believe that educating people about environmental issues can be done to slow climate change (35%), but they tend to believe media information than others.

CONCLUSION

The conclusion of the study is that more than 50% of science teachers and pre-service science teachers have a false conception of global phenomena such as global warming, climate change, ozone depletion, and acid rain. Some science teachers and pre-service science teachers view that global warming is the cause of climate change caused by ozone depletion and although they are the main actor of education, they have no belief that education can change human behaviors in facing the global climate phenomenon and they believe that, instead, media can do it better.

REFERENCES

- Anwar, S. (2008). Alternatif Kebijakan Sekolah dalam Mewujudkan Program Go Green School sebagai Antisipasi Dampak Pemanasan Global. In *Proceeding of Annual Scientific Meeting of National Geography Ties Indonesia to XI* (pp. 1–11).
- Bord, R. J., Connor, R. E. O., Fisher, A., & O'Connor, R. E. (2000). In What Sense Does The Public Need to Understand Global Climate Change? *Public Understanding of Science*, 9(3), 205–218.
- Bradshaw, C. J. A., Giam, X., & Sodhi, N. S. (2010). Evaluating The Relative Environmental Impact of Countries. *PLoS ONE*, 5(5).
- Choi, S., Niyogi, D., Shepardson, D. P., & Charusombat, U. (2010). Do Earth and Environmental Science Textbooks Promote Middle and High School Students' Conceptual Development about Climate Change? Textbooks' Consideration of Students' Misconceptions. *Bulletin of the American Meteorological Society*, 91(7), 889–898.
- Courtenay-Hall, P., & Rogers, L. (2002). Gaps in Mind: Problems in Environmental Knowledge-Behaviour Modelling Research. *Environmental Education Research*, 8(3), 283–297.
- Daniel, B., & Stanisstreet, Martin Boyes, E. (2004). How Can We Best Reduce Global Warming? School Students' Ideas and Misconceptions. *International Journal of Environmental Studies*, 61(2), 211–222.
- Fakhriyah, F., Masfuah, S., Roysa, M., Rusilowati, A., & Rahayu, E. S. (2017). Student's Science Literacy in the Aspect of Content Science? *Jurnal Pendidikan IPA Indonesia*, 6(1), 81–87.
- Helgeson, J., van der Linden, S., & Chabay, I. (2012). The Role of Knowledge, Learning and Mental Models in Public Perceptions of Climate Change Related Risks. *Learning for Sustainability in Times of Accelerating Change*, 329–346.
- Kaloko, E. L., & S. Z. (2016). Persepsi dan Tingkat Pengetahuan Siswa tentang Keanekaragaman Hayati dan Pemanasan Global di SMA Se-Kecamatan Tigalingga. *Jurnal Pelita Pendidikan*, 4(3), 292–299.
- Karl, T. R. (2003). Modern Global Climate Change. *Science*, 302(5651), 1719–1723.
- Khalid, T. (2003). Pre-service High School Teachers' Perceptions of Three Environmental Phenomena. *Environmental Education Research*, 9(1), 35–50.
- Kılınç, a, Stanisstreet, M., & Boyes, E. (2008). Turkish Students' Ideas about Global Warming. *International Journal of Environmental and Science Education*, 3(2), 89–98.

- Krosnick, J. A., Holbrook, A. L., Lowe, L., & Visser, P. S. (2006). The Origins and Consequences of Democratic Citizens' Policy Agendas: A Study of Popular Concern about Global Warming. *Climatic Change*, 77(1), 7-43.
- Leiserowitz, A. (2006). Climate Change Risk Perception and Policy Preferences: The Role of Affect, Imagery, and Values. *Climatic Change*, 77(1), 45-72.
- Marwan, A., & Sweeney, T. (2010). Teachers' Perceptions of Educational Technology Integration in An Indonesian Polytechnic. *Asia Pacific Journal of Education*, 30(4), 463-476.
- Mostafa, M. M. (2007). Gender Differences in Egyptian Consumers' Green Purchase Behaviour: The Effects of Environmental Knowledge, Concern and Attitude. *International Journal of Consumer Studies*, 31(3), 220-229.
- Nam, Y., & Ito, E. (2011). A Climate Change Course for Undergraduate Students. *Journal of Geoscience Education*, 59(4), 229.
- Pekel, F. O., & Aÿ-zay, E. (2005). Turkish High School Students' Perceptions of Ozone Layer Depletion. *Applied Environmental Education & Communication*, 4(2), 115-123.
- Porter, D., Weaver, A. J., & Raptis, H. (2012). Assessing Students' Learning about Fundamental Concepts of Climate Change Under Two Different Conditions. *Environmental Education Research*, 18(5), 665-686.
- Pruneau, D., Liboiron, L., Vrain, E., Gravel, H., Bourque, W., & Langis, J. (2001). People's Ideas about Climate Change: A Source of Inspiration for the Creation of Educational Programs. *Canadian Journal of Environmental Education*, 6(1), 121-138.
- Rampino, M. R., Self, S., & Fairbridge, R. W. (1979). Can Rapid Climatic Change Cause Volcanic Eruptions?. *Science*, 206 (4420), 826-829.
- Ryghaug, M., Holtan Sorensen, K., & Naess, R. (2011). Making Sense of Global Warming: Norwegians Appropriating Knowledge of Anthropogenic Climate Change. *Public Understanding of Science*, 20(6), 778-795.
- S. R. Yunus, I. G. M. Sanjaya, B. Jatmiko. (2013). Implementasi Pembelajaran Fisika Berbasis Guided Inquiry untuk Meningkatkan Hasil Belajar Siswa Auditorik. *Jurnal Pendidikan IPA Indonesia*, 2(1), 48-52.
- Shepardson, D. P., Niyogi, D., Roychoudhury, A., & Hirsch, A. (2012). Conceptualizing Climate Change in The Context of A Climate System: Implications for Climate and Environmental Education. *Environmental Education Research*, 18(3), 323-352.
- Solomon, S., Daniel, J. S., Neely, R. R., Vernier, J.-P., Dutton, E. G., & Thomason, L. W. (2011). The Persistently Variable "Background" Stratospheric Aerosol Layer and Global Climate Change. *Science*, 333(6044), 866-870.
- Spence, A., Poortinga, W., Butler, C., & Pidgeon, N. F. (2011). Perceptions of Climate Change and Willingness to Save Energy Related to Flood Experience. *Nature Climate Change*, 1(1), 46-49.
- Tran, L. U., Payne, D. L., & Whitley, L. (2010). Research on learning and teaching ocean and aquatic sciences. *NMEA Special Report*, 3(1), 22-26.
- Tjasyono B. (1986). *Iklm dan Lingkungan*. Bandung: P.T. Cendana Jaya Utama.
- Tjasyono B. (2006). *Klimatologi*. Bandung: ITB.
- Triastuti, U. H., Tedjakusuma, E. E., Sriyanti, Giriana, M., Darajati, W., Hernowo, B., Mintzer, I. (2009). Indonesia Climate Change Sectoral Roadmap ICCSR Synthesis Report.
- Widiyanti, F., Indriyanti, D. R., & Ngabekti, S. (2015). The Effectiveness of The Application of Scientific Literacy-Based Natural Science Teaching Set toward The Students' Learning Activities and Outcomes on The Topic of The Interaction of Living Organism and Environment. *Jurnal Pendidikan IPA Indonesia*, 4(1), 20-24.