Elementary Teachers' Knowledge and Teaching of Climate Change

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ABSTRACT

This study examines eighteen elementary teachers knowledge and teaching practrice of climate change using the KQEM survey, modified from the survey developed by Leiserowitz, A., Smith, N. & Marlon, J.R. (2010). The survey includes 11 questions from KQEM survey and 2 open ended questions about teachers' knowledge of climate change and their understandings of important climate change concept for elementary students. All of the participant teachers were purposefully selected for the study and were participated in the study volunteerly. The data for this study were analyzed both quantitatively and qualitatively. The result of this study indicates that the teachers have knowledge of climate change specifically about the topics of causes of climate change and consequences of climate change such as shifting biome and ecological impacts. While most of the teachers described climate change phenomena using scientific knowledge, some of the teachers (N=2) showed misconceptions about climate change phenomena. Most of the teachers thought the causes of climate change and potential solutions to reduce climate change are important concept that elementary students need to understand about climate change. Actually, most of the teachers are currently teaching the causes and consequences of climate change (N=13) potential solutions to global warming (N= 8). This study could inform teacher educators about what elementary teachers understand about climate change and what elementary teachers are currently teaching about climate change.

Key words : climate change education, elementary teacher education, knowledge of climate change.

Ⅰ. Introduction

A recently published survey about American's knowledge of climate change (Leiserowitz, Smith, & Marlon, 2010) indicates that "many Americans lack some of the knowledge needed for informed decision-making in a democratic society" (p.4). As public concerns about changing global environment and climate increase, climate change education for elementary students become very important issue to preparing them as scientifically literate future citizen.

While teaching climate change is very critical for elementary students, elementary teachers' knowledge of climate change and their beliefs about climate change has not been studied enough to inform teacher educators. While there are some studies about elementray preservice teachers'understandings of climate change related topics such as greenhouse gas greenhouse gas (e.g. Boyes, 1995), ozone (Dove, 1996), there are few studies about inservice elementary teachers' understandings of these concepts. Thus, understanding inservice elementary teachers' knowledge and beliefs of climate change is very important not only for understanding what they have been teaching about climate change but also for preparing preservice elementary teachers to teach sound climate change knowledge for our future citizens.

This study examine eighteen elementary teachers knowledge and teaching practice of climate change using a modified survey from American's Knowledge of Climate Change (Leiserowitz, Smith, & Marlon, 2010), developed by KQEM (Public Media for Northern California). The modified survey includes 11 questions

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from KQEM survey and 2 open ended questions about teachers' knowledge of climate change and their understandings of important climate change concept for elementary students. The specific questions for this study are:

1) What are the elementary teacher's understandings of climate change?
2) How do the elementary teachers teach climate change?

Ⅱ. Literature Review

Climate change is very complex and interdisciplinary topic that includes different science discipline as well as social science (Anderson & Wallin, 2000). Thus defining knowledge of climate change and measuring it is also not an easy task for many science educators. In the study of American's Knowledge of Climate Change, Leiserowitz, Smith, & Marlon, 2010, described knowledge about climate change using several general and overlapping categories of the knowledge: "knowledge about how the climate system works; specific knowledge about the causes, consequences, and potential solutions to global warming; contextual knowledge placing human-caused global warming in historical and geographic perspective; and practical knowledge that enables individual and collective action" (p.5). As above categories show, knowledge of climate change includes not only science knowledge of climate system but also social science knowledge of human impact on climate change.

During last two decade, the studies of students' and public understandings of climate change has been dramatically increased (e.g. Bostrom, Morgan, Fischhoff, & Read, 1994; Boyes, Chuckran, & Stanisstreet, 1993; National Environmental Education and Training Foundation, 2005; Osterlind, 2005; Rebich & Gautier, 2005; Sterman & Sweeney, 2009). However, there is relatively little study about teacher's understandings of climate change (e.g. Boyes, 1995; Dove, 1996; Fortner, 2001; Summers et al., 2001).

Most of the studies about elementary teachers' understanding of climate change has not measured the complex knowledge of climate change but simple concepts related to the knowledge such as greenhouse gas (e.g. Boyes, 1995), ozone (Dove, 1996) and so on. These studies indicated that elementary teacher's lack of understandings of these scientific concepts of climate change. These studies could not inform us enough about elementary teachers' complex knowledge of climate change. Moreover, there is little study about elementary teacher's beliefs about climate change such as their trusts in different information sources about climate change knowledge, or their perceptions of climate change risk. To understand elementary teacher's knowledge of climate change, this study examine elementary teachers knowledge of climate change phenomena using open-ended questions as well as well developed survey.

Ⅲ. Method

1. Participants

Eighteen elementary teachers have more than 10 years of teaching experiences were purposefully selected for the study. The elementary teachers participated in this study volunteerly. All the teachers were female and they had experience of teaching all the elementary grade level (1st trough 6th) before the study. Currently they were teaching various elementary grade levels (1st grade (N=3), 2nd grade (N=4), 3rd grade (N=3), 4th grade (N=5), 5th grade (N=1), and 6th grade (N=2)) at elementary schools in Pusan metropolitan city, South Korea.

2. Data collection

The survey for this study is from a simplified version of the Leiserowitz, Smith, & Marlon, (2010)' survey, which is made by KQED, "Public Media for Northern California". We added two open-ended questions asking the teacher participants to describe; 1) general idea of climate change using their knowledge of climate change and 2) use of the topics related to climate change for their teaching. In addition to examining the teacher knowledge of climate change, the survey also included the questions about the teachers' desire for more information about climate change, trust in different information sources, and climate change risk perceptions,

and behaviors.

3. Data analysis

We used both quantitative and qualitative analysis methods. We quantitatively analyze survey questions data using descriptive statistics. We also used inductive approach for analyzing open-ended questions. Inductive approach is, as Patton (2002) described, finding emerging themes from the data instead of using predetermined patterns. Thus, first, we read the data carefully to find emerging themes from the data then developed categories to describe the themes. Here the themes represents knowledge categories or topics related to climate change knowledge. Then we developed overarching themes related to our research questions. Three researchers participated in the data analysis process in order to enhance the authenticity of the interpretations and the credibility of the findings (Patton, 2002).

Ⅳ. Findings

1. Elementary Teachers' Knowledge of Climate Change

From the analysis of the teachers' answers from the questions asking the teachers'knowledge of climate change, we found that the teachers'knowledge of climate change can be summarized by the four knowledge categories presented in the following Table 1. The teachers described climate change related phenomena by focusing the topics of Extreme weather conditions including natural disasters, Causes of climate change, Consequences related to climate change such as sea level change and temperature increase, and Ecosystem change or shifting biome.

As Table 1 present, seven of the teachers thought the climate change phenomena is related to extreme weather conditions and natural disasters such as flood, drought, and heat waves. Six of the teachers also described about ecosystem change and biome shifting as part of consequences of climate change. They also directly correlate global climate change with the phenomena of global temperature increase and sea level change. They did not mentioned about climate change in earth history and considered current temperature increase as climate change. Some of the teachers also (N=6) mentioned volcanic activity, change of solar surface activity, and increased carbon dioxide in the atmosphere as important causes of climate change.

While most of the teachers understand climate change knowledge correctly, two of the teachers addressed misconceptions of climate change. They thought seasonal variations of weather patters such as El Nino or La Nina as consequences of global climate change. They also thought that the natural disaster due to geologic event such as Tsunami as part of climate change.

All of the teachers agreed that they think climate change is happening and 50% of the teachers were very sure and another 50% of the teachers were somewhat sure about their answer that climate change is happening. For the question about the causes of climate change, more than half of the teachers (N=10) chose "Human activities and natural changes" as major cause of climate change and the other teachers (N=9) chose just "human activity" as cause of climate change. Most of the teachers (N=13) also thought that "Most scientists think climate change is happening" and only three of them thought that "there is a lot of disagreement on weather climate change is happening".

Table 1. Elementary teachers' descriptions of climate change phenomena

Climate Change Phenomena	N
Extreme weather pattern/ Natural Disasters	7
Causes of climate change	6
Sea level increase and global warming	6
Ecosystem change/shifting biome	4
Misconceptions (pollution, Tsunami, Seasonal pattern (El Nino, La Nina)	4

For the answer of the question, "When do you think climate change will start to harm people in Korea", about 30% of the teachers (N=6) chose, "Now". and another 30% of the teachers chose "After 25 years". The rest of the teachers choose “After 10 years” or “After 50 years ″. In other words, 70% of the teachers thought climate change would not happen now but in the future.

For the question about the teachers’ beliefs about the possibility of “Human could reduce current climate change phenomena”, 50% of the teachers (N=9) chose that "Humans could reduce climate change, but it is unclear at this point whether we will do what is needed". 30 % of the teachers chose that "Humans can reduce climate change, and we are going to do so successfully". Two of them chose that “Human cannot reduce climate change, even if it is happening” This result shows that only 30% of the teachers were positive about human can reduce climate change.

2. Elementary Teachers' Teaching of Climate Change

The climate change knowledge that the teachers thought that elementary students need to understand about climate change can be summarized by the five knowledge categories that Leiserowitz, Smith, & Marlon, (2010) suggested. The table 2 present the climate change knowledge that the teachers choose based on the categories. As the table 2 presents, most of the elementary teachers (N=12) thought that the second knowledge category; "specific knowledge about the causes, consequences, and potential solutions to global warming, is important knowledge that their elementary students need to understand. Seven of the teachers also mentioned that human caused global warming is also important knowledge that elementary students need to understand. Specifically, the teachers in this category mentioned the importance of local climate condition knowledge and the consequences of the climate change in specific local contexts. The importance of practical knowledge for reducing greenhouse gases and environmental behaviors to reduce climate change were also mentioned by two of the teachers.

Based on the analysis of what topics the teachers are currently teaching, we found that most of the teachers are teaching topics related to causes and consequences of climate change (N=13). Many of them also described that they are teaching about potential solutions to global warming (N= 8). This result is overlapped with the result we found from the first research question about what the teachers know of climate change. In other words, the teachers teach climate change knowledge that they feel confident in teaching it. Interestingly, relatively small number of the teachers choose "the impact of climate change on South Korea" as the topic that they are currently teaching about climate change. They also indicated that "conflicts with science standard" as the biggest challenge that they are not teaching climate change.

3. Discussion and Implications

In the context of global climate change, teaching science of climate change for elementary students is very critical for preparing them as scientifically literate citizens who will face to make important decisions for our future environment. However, teaching climate change is a challenge for most of the elementary teachers due to the complexity of th social and scientific issues related to climate change and their lack of scientfic knowledge of climate change. This study will inform us about what teachers know about climate change and what climate change knowledge they think elementary students should

Table 2. Important climate change knowledge that elementary students need to understand.

Climate Change Knowledge Category	N
Knowledge about how the climate system works	2
Specific knowledge about the causes, consequences, and potential solutions to global warming;	12
Contextual knowledge placing human-caused global warming in historical and geographic perspective;	7
Practical knowledge that enables individual and collective action	2

understand.

The result of this study indicate that most of the elementary teachers knew that extreme weather patterns and natural disasters are critical indicators of climate change. However, they could not recognize that current global warming is a part of climate change in the long history of earth geologic event. They did not consider lower temperature phenomena during earth history such as ice age as global climate change. They also did not mentioned that climate change happened many times during earth history. Consequently, they thought climate change is global temperature increase of global warming. All of the teachers believed that climate change is currently happening and will affect human health in South Korea sooner (Now) or later as 10-50 years. While the teachers concerned about the climate change phenomena that could affect current natural environment such as biome shifting, only 30% of them were positive about human can reduce global climate change.

While most of the teachers described climate change phenomena correctly, some of the teachers addressed misconceptions about the causes and consequences of climate change. Two of the teachers mentioned seasonal weather pattern change or Tsunami as indicator of climate change. All of the teachers chose human as major cause of climate change and more than half of the teachers (N=10) also chose natural events such as volcanic eruption as most important causes of climate change. Most of them (N=13) also thought that "Most scientists think climate change is happening"

The teachers wanted to know more about climate change knowledge, specifically about the effects of climate change on living things and potential solutions to reduce climate change.

Most of the teachers thought the causes of climate change and potential solutions to reduce climate change are important concept that elementary students need to understand about climate change. Actually, most of the teachers are currently teaching the causes and consequences of climate change (N=13) potential solutions to global warming (N= 8). This results indicate that the teachers are teaching about the climate change topic that they are familiar with. In other words, what the teachers are teaching about climate change is strongly tied with what they will teach about climate change. More importantly, while most of the teachers agree that climate change is very important concept that elementary students need to understand, they could not teach it when it conflicts with school science standards or because of their lack of knowledge.

This study implies that teacher educators need to support elementary teachers' knowledge of climate change, particularly about potential solutions to reduce climate change and the impact of climate change on local areas, South Korea. Particularly, teacher educators need to help teachers to understand climate change in earth history that current climate change is one of many climate change happened in earth history. Other researchers indicated that teachers's lack of understandings of geologic time scales (Trend, 2000, 2001). As Trend (1998) suggested that the concept of geologic time scale (or the concept of deep time) is "unique in providing the fundamental framework into which geological events and other phenomena can be located" (p.976). More importantly, knowledge of geologic time scale would help teachers to understand important evidence within the climate change debate about whether global climate change is human induced or part of a natural cycle.

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