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Climate Change and Environmental Education: The Application of Concept Map for Representing the Knowledge Complexity of Climate Change

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Abstract**—**It has formed an essential issue that Climate Change, composed of highly knowledge complexity, reveals its significant impact on human existence. Therefore, specific national policies, some of which present the educational aspects, have been published for overcoming the imperative problem. Accordingly, the study aims to analyze as well as integrate the relationship between Climate Change and environmental education and apply the perspective of concept map to represent the knowledge contents and structures of Climate Change; by doing so, knowledge contents of Climate Change could be represented in an even more comprehensive way and manipulated as the tool for environmental education. The method adapted for this study is knowledge conversion model compounded of the platform for experts and teachers, who were the participants for this study, to cooperate and combine each participant's standpoints into a complete knowledge framework that is the foundation for structuring the concept map. The result of this research contains the important concepts, the precise propositions and the entire concept map for representing the robust concepts of Climate Change.

Keywords**—**Climate Change, knowledge complexity, concept map.

I. Introduction

THIS Climate Change can be attributed to, from a scientific perspective, dramatic increase in energy consumption including vast disafforestation and excessive land resources exploitation, which are
closely associated with carbon-cycle imbalance across the world, as a result of rapid global economic development ever since the Industrial Revolution, as pointed out by four Assessment Reports issued by the Intergovernmental Panel on Climate Change (IPCC) during 2001-2007. To tackle such challenges and risks as climate disasters, global warming and climate change, major strategies of "mitigation" and "adaptation" have been rendered in Framework Convention on Climate Change (UNFCCC). In view of this, relative measures have been taken internationally. For example, the Kyoto Protocol, a protocol to the UNFCCC, was adopted in Kyoto, Japan in 1997, aiming to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" and demanding reduction of greenhouse gas emissions by signatories for the period 2008-2012. In Taiwan, the Executive Yuan brought forward the *Sustainable Energy Policy Guidelines* in June 2008 and promulgated in the same year the *Measures for Comprehensive Energy Saving and Carbon Reduction in Government Offices and Schools*, while its Environmental Protection Administration announced the *Plan of Nationwide Energy Saving and Carbon Reduction Campaign* the next month that year, in the hope that the government and the people make joint effort in promoting energy saving and carbon reduction, forming corresponding habits, developing low-carbon economy and researching other energies and technologies. Combining the strategies of "mitigation" and "adaptation" with environmental education, these actions aim to implement the strategies starting from the level of education. Therefore, we must consider knowledge characteristics of climate change issues so as to facilitate integrating such knowledge into environmental education.

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Knowledge concerning climate change includes interacting variables in the nature, dynamic systems formed by such variables and specialized knowledge, featuring high knowledge complexity. To meet this challenge, we adopt Concept Map which provides us with a macro scope as it is a representation output of an individual's knowledge structure and understandings of a proposition, applicable for handling complicated, uncertain and developing dynamic disciplines[1]. Besides, we discovered, through educational experiments, that learning Concept Map helps students learn easier, strengthen memory and improve understanding of knowledge structure and that it can also be applied to such educational activities as knowledge extraction and structuralization[2].

As a graphical tool, Concept map (CM) was first developed by Novak and Gowin (1984) based on cognitive theories by Ausubel (1968). Mainly used to represent an individual's conceptual knowledge, it shows a group of related concepts in a certain proposition[7]. Concept Map includes such basic elements as Concept, Link and Linking Word. A "concept" could be an object or event. "Links" and "link words" between concepts serve as representation of relations between these concepts; they confirm a concept and link general concepts to form a hierarchical, netlike and demonstrating organic structure [9]. Therefore, Concept Map can be considered as an important tool for acquiring specialized knowledge and imparting knowledge. As a result, based on the idea of Concept Map, this study adopts the view of holism and employs experts in the field of climate change to try to analysis related complicated subjects, present a complete knowledge structure by means of Concept Map and then restructure the knowledge structure of global climate change.

II. Discussion Of References

A. Climate Change in the View of Environmental Education

Environmental education is “a learning process during which individuals and social groups increase their knowledge about the environment and interactions among its elements like organisms, physical factors and social factors, acquire necessary knowledge, skills and values and take actions individually or collectively to address environmental problems today and tomorrow”. In other words, instead of nature study, outdoor education or merely environmental knowledge impartation, environmental education is indeed education on values and emphasizes action and solution. Just as environmental problems are complicated involving natural ecosystems and social structures, inter-discipline environmental education thereupon analyzes these problems from a holistic view. Because solutions to environmental problems must be achieved through social operations, environmental education features worldwide education and lifelong education.

Along with climate change, natural disasters are increasingly frequently happening to threaten organisms, ecosystems, social economies and so on in the world. Focusing on Taiwan, in addition to restrictions of being an island country, huge amount of consumption of traditional energies (coal, oil and gas) not only makes Taiwan one of major contributing countries of greenhouse gases, but also brings about enormous threats to people’s life and industries. Environmental education can, from various aspects of science, environment, society, economy, institution, lifestyle, technology, ideology, values, etc., probe into applicable countermeasures for Taiwan to fight against climate change and promote related learning and actions so as to change people’s thinking and lifestyle and work out locally suitable mitigation and adaptation strategies.

B . Knowledge Complexity concerning Climate Change

As one of knowledge characteristics, knowledge complexity usually exists in various bodies of knowledge. It is a general term and related to understandability of an issue, level of complexity for mental representation of the issue, specialized knowledge and the status formed by interacting matters. For climate change, as it is a process with interacting natural variables, human activities, environmental changes and interaction among objects will all affect its development. In other words, such variables as global warming and human activities shall be taken into consideration when we discuss climate change. For example, when observed from the view of sociology, climate change is not simply an issue of fighting against the natural. The values of anthropocentrism and desires and prejudices rise from capitalism shall be blamed for climate disasters. With shortsighted success and benefits and attempts to conquer the nature flood the human society, all unreasonable developments are accepted as reasonable. The progressing material civilization is irresistible and capitalism becomes the mainstream values. Only with a radical transform in human’s outlook on the world followed by another fundamental change can our values be shifted and tackling climate change realized. Therefore, it is far beyond common scope of knowledge to impart knowledge and construct causal relations concerning climate change [1], [5]. As high knowledge complexity increases the difficulties in mental representation, practical representation means are needed to demonstrate complicated knowledge body of climate change and to provide knowledge users with right and understandable representation patterns.

C. Concept Map and Its Application to Restructuring Climate-Change Knowledge

Based on cognitive theories by Ausuble, Novak (1984), a scholar with the Cornell University in the US, brought forward the idea of Concept Map. It represents meaningful relations between concepts by means of proposition. Two or more concepts are linked by some special ways to form a meaningful or meaningless proposition. The whole concept map features a hierarchical structure. Concept Map consists of Concept, Link, Linking Word and Cross Link. In the field of education, Concept Map focuses on ranking knowledge and articulating related concepts with links and link words to construct a netlike concept map [16],[6]. Such a map of more than one dimension represents all hierarchical or propositional relations within the concept system or its subsystems of a certain discipline, thus applicable in many disciplines and fields [8] . This helps students understand known relationships between concepts and new relations between known concepts, organize knowledge structure in a non-formulary way, and consequently develop new concepts[15]. Besides, as a graphical tool representing knowledge and by means of multi-dimensional diagram with codes of inter-concept relation, Concept Map presents organized knowledge and flexibly adjusts its contents following different thinking, thus helps its users to understand, integrate and overview knowledge of various disciplines[3].

D. *Interim Summary*

From the perspective of status quo of human being’s living environment, climate change has become one of critical topics. While in the view of environmental education, knowledge concerning climate change issues features specific disciplines and knowledge complexity. Therefore, in educational activities, we shall consider knowledge characteristics and adopt practical ways and tools to represent complicated knowledge body of climate change. This Study takes the concepts of “cognitive schema” and “meaningful learning” as its basis, forms a professional body with experts and teachers from various educational stages and integrates advice and knowledge modes to jointly guide concept mapping, with concept maps representing knowledge concerning climate change.

III. Methods For Study

A. Framework of Study

This study adopts the method of soliciting opinions from experts. Concept maps will be revised following opinions collected from experts’ meetings or individual expert consultations. The professional body, consisting of experts, scholars and teachers from various educational stages, takes a wide range of theoretical bases and field-education requirements as guidelines for drawing and revising concept maps. It has four professors from departments of Geosciences, Atmospheric Sciences and Chemical Engineering, National Taiwan University, three professors from the Graduate

Institute of Environmental Education, National Taiwan Normal University, and totally twenty-two teachers involved in subjects concerning climate change from elementary, junior high and senior high schools in Taipei City and Taipei County. Diagram 1 below shows the framework of this study.

According to the results of experts' selection, the selected concepts for this study, via significance of qui square test , were divided into two dimensions that are composed of omitted concepts and adapted concepts which are necessarily instructed in elementary school, junior high school, and senior high school ; furthermore, the systematic graph of complete concepts , shown as the diagram 1, was framed on the basis of these classified concepts.

B. Documents for Study

For selection of documents, the IPCC Fourth Assessment Report (AR4) and Annual Reports composed by Christopher Flavin et al from the Worldwatch Institute, a famous American think-tank, serve as sources for analysis. To screen out major concepts, every report has been read for several times. With open coding programs of the Grounded Theory, the above-mentioned sources are decomposed, viewed, compared and conceptualized for categorizing similar knowledge and then discovering connotative relations and logical links between categories. In this way, major concepts and related minor concepts are picked out. Concepts screened out are summarized for clustering and ordering based on super ordinate-subordinate relationships that each major concept features. Thus clusters and categories are made and relations between concepts are reflected, with the most extensive, general or recapitulative concepts on the top while the rest hierarchically arranged downward till specialized or materialized concepts.

IV. Results Of Study

With knowledge shared and exchanged by the professional body, this study integrates concepts concerning climate change issues and on this basis drew the concept map. Below, Table 1 is the summary of the major concepts, and Diagram 2 the concept map concerning climate change. Based on all concepts collected and sorted by the researchers, a holistic concept of climate change can be established to provide learners and teachers with a basically complete macro-system and an integrated concept concerning climate change. The concept map, Diagram 1 below, is drawn to represent relations between concepts in a hierarchical structure.

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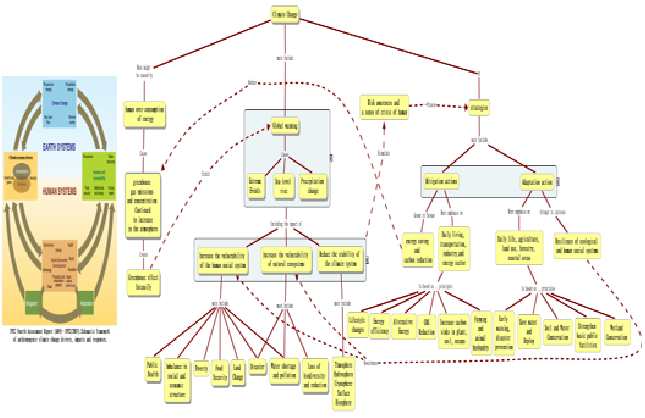

Fig .1 Diagram 1 Concept Map concerning Climate Chang