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A Critical Discourse Analysis of Energy-related Contents in National Textbooks of China, Japan, and Korea

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Abstract

Climate change has increased concern for sustainability around the globe. In particular, energy-related issues have been receiving significant attention, as energy-related issues such as energy use, energy security, energy security, and the energy crisis are intrinsically related to the sustainability of our human society. Among the various academic attempts to address these concerns, educational efforts have garnered attention from experts in diverse fields due to the realization of the importance of involving citizens and future stakeholders in the green movement. Therefore, this study examines how energy-related contents are designed and delivered in the national educational environments of China, Japan, and Korea, which are major energy-consuming countries in Asia.

With a comprehensive understanding of energy as the force that runs the earth and provides links for humanity — not merely a means to sustain economic development — it is argued that the concept of ecological citizenship, which questions industrialism, is a desirable educational goal. The concept promotes the development of ecological empathy and the nurturing of green political thought and green competence. However, national education sometimes inhibits the development of such a normative virtue because it is often regarded as the arrangement of a desired ideology prepared by a dominant power. Hence, with this theoretical background, the questions arise of how energy-related texts are written and what the explicit and implicit implications of the texts are.

China, Japan, and Korea are all well known for their centralized educational systems in which the curriculum and textbook systems are all controlled by governmental agents. As all three nations cover nine years of compulsory education, a total of 111 middle-school science and social studies national textbooks are collected and 46 of them are finally selected as those with energy-related content. The present research adopted a critical

discourse analysis approach so as to interpret implicitly and explicitly embedded messages of energy-related texts. In other words, the study views texts in national textbooks as a discourse that is promoted by mainstream politics. Through this study, it is concluded that as climate change is becoming a global concern, the three nations are all devising countermeasure strategies in accordance with their social, political, and economic cultures. These strategies are then projected onto the curricula and textbooks.

What is found in this study is a standardized means of explaining energy and energy issues that is also in line with national social and political cultures. For example, general concerns about energy issues with respect to environmental problems, issues related to finite resources, the need for new and renewable energy sources, and the safe and efficient use of electric energy are common contents emphasized in all three nations' textbooks. Different contents, such as population growth in the case of China, the energy-crisis experiences in the case of Japan, and the green growth paradigm in Korea also seem to be related to the different national interests and conditions. Also, science textbooks tend to contain more energy-related content than social studies textbooks do, often entailing an optimistic attitude toward science and technology. No integrated explanation of energy and energy-related issues is provided, and energy is chiefly described as a power-providing source that is essential for sustaining the status quo. In particular, nuclear energy-related contents, in all three cases, are limited not only in terms of how much space is allocated but in terms of how the related contents are described. It is argued that such results illustrate the natural characteristics of nuclear energy being an authoritarian technology. Furthermore, other voices that place emphasis on social justice and ecological empathy are negated in the textbooks. Thus, it can be assumed that the interests of the discourse as reflected in the examined energy-related contents lies in maintaining the current dominant system; therefore, students are naturally considered as willing recipients of legitimate knowledge, individual energy consumers with the responsibility to exercise

efficient energy use, and often as future scientists who can develop advanced energy technologies. These results suggest that not one of the nations is prepared to implement the concept of ecological citizenship in an educational setting.

Of course, opportunities for multiple readings still exist and therefore a more precise investigation of texts in national schoolbooks with various methodological approaches and more questions about framing energy-related issues are encouraged research topics for future studies. The present study will hopefully contribute to the process of questioning the role of current education systems as well as the mainstream's strategies to approach energy-related issues in the light of sustainability.

- **Keywords:** Critical Discourse Analysis, Ecological Citizenship, Energy, Environmental Education, National Curriculum, Nuclear Energy, Power, Texts
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I. Introduction

Climate change and its impacts on the environment, as well as consequent social problems, have become common global concerns. In Article One of the United Nations Framework Convention on Climate Change (UNFCCC), it defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." In other words, anthropogenic factors are seen to significantly contribute to climate change whereas climate variability is likely caused by natural factors. The Intergovernmental Panel on Climate Change (IPCC) also acknowledges human activities in causing climate change by using the adverb "very likely," in its fourth report (Pachauri & Reisinger, 2007). Notwithstanding the controversial debate on the human causes of climate change, more and more academics and experts are focusing on the strategies or methods to approach this concern. Yun (2009), for example, states that this is the age in which humans have to discuss how to solve the related problem, and not focus on who is responsible for causing the problem.

Anthropogenic greenhouse gas (GHG) emissions are regarded as a major driver of climate change (IPCC, 2007). This, then, leads human societies to another significant discussion: on energy. Energy use, energy efficient technologies, energy security, and energy crisis are all integrally related to the sustainability of human societies. In fact, scientific insight on energy had already begun as early as 1940s by Leslie A. White. In his article "Energy and the Evolution of Culture," energy is defined as "the capacity for performing work (1943)," and it is stated that it has been another harnessed source of energy that has accelerated or facilitated the advancement of human culture. While it is not easy to completely agree with his praise for energy in the course of cultural evolution, in this era of

climate change, it is true that the 'development' of human societies has largely relied upon energy. In this regard, his insight on the importance of energy as a source for human activities and development, is even more reflective of today's societies that are dependent on energy in sustaining every activity. Today's concerns toward energy security can be summarized as follows (Thomas, Jennings, and Lloyd, 2008):

> The consumption of energy plays a pivotal role in the economic development of the industrialised world. Approximately 80% of the world's total primary energy consumption is accounted for by fossil fuels and this poses a significant challenge for the future as oil production peaks and begins to decline and we simultaneously face anthropogenic climate change caused primarily by the burning of fossil fuels. The twin threats of climate change and oil depletion leading to energy insecurity in both the industrialised and developing world are driving an increase in demand for renewable energy generation.

This is probably the reason why energy consumption is a key determinant in indicators such as *carbon footprint* or *ecological footprint* that are used to evaluate the impact of humans on earth. If these two indicators are useful for incorporating the energy use at the individual and local levels, there are also a few international organizations that deal with energy-related research and studies at the national and global levels, such as the International Energy Agency (IEA), and the World Energy Council.

Energy-related issues are especially prominent in the Asian region because of its growing population and the economic development of some of its countries, such as China and India (Tow, 2007; Wu, Brown, & Siddiqi, 2007). According to the IEA, the total primary energy supply (TPES) of Asia, excluding China, increased from 5.5 % of the world's total supply in 1973 to 12.0% in 2010, whereas the global share of the OECD member countries decreased from 61.4% to 42.4% between 1973 and 2010. China, of course, is not an exception. The nation's TPES skyrocketed to 19.1% of the world's total supply in 2010, from a share of 7.0% in 1973 (IEA, 2012). Among nations of the Asia-Pacific region, China, Japan, and South Korea are the largest energy consumers, while India is the largest consumer in the South-Asia region (IEA, 2012; Wu et al., 2007). These

increasing regional trends are expected to continue, not only due to the increasing regional population, but also due to the fact that rapid economic development tends to result in the increase in energy consumption (Thomas et al., 2008; Wu et al., 2007). Furthermore, because the rate of energy production is far below the amount of energy consumption, some experts state that these regions are faced with an energy dilemma (Wu et al., 2007). This implies that if there is no effort either to secure another alternative energy source or to reduce energy consumption, or attain both, the region will encounter an energy crisis in the future. On the other hand, economists and politicians who place priority on economic development argue that only focusing on such efforts would slow the economic growths of their countries.

In attempting to resolve the global environmental and energy issues, there have been various worldwide efforts in almost every sector: economic, political, social, cultural, and educational. It is common nowadays to find "green" or "sustainable development" ideas or concepts in the economic, political, social, cultural, and educational fields. Education, in particular, is getting noticeable attention from many experts and academics, as most of them acknowledge that efforts toward sustainability should be made not only by governments, but also by their citizens (Dobson, 2006). One example is Education for Sustainable Development (ESD) that has been promoted by United Nations Educational, Scientific and Cultural Organization (henceforth, UNESCO) since 2005 with the project "The UN Decade of Education for Sustainable Development." Furthermore, Andrew Dobson, the author of *Green Political Thought*, has developed the concepts of *environmental citizenship* and *ecological citizenship* and reviewed the British national curriculum to analyze the feasibility of ecological citizenship education in England (Dobson, 2003).

When examining similar developments in the Asian region again, it is found that environmental education in the Asia-Pacific region had, in fact, begun before the ESD was promoted by the UNESCO, due to some

regional environmental problems. For example, issue 22 of the Bulletin of the UNESCO Regional Office for Education in Asia and the Pacific, titled "Environmental Education in Asia and the Pacific," stated that environmental education was being conducted in 17 countries in the region (1981).[1] This article emphasized that deforestation and the world energy problem, *i.e.*, firewood supply, were the major reasons why the region required environmental education. Although the sources of energy have been expanding towards crude oil, natural gas, coal, nuclear production, and hydro production,[2] the tension toward the energy crisis still exists as the population continues to grow in this region. This tension is reflected in much scholarly work that has been done on the topic of energy security of the region. The issues discussed range from securing enough level of energy for the economies to the expected environmental issues emanating from the use of coal and oil (Doh, 2003; Tow, 2007). Such tension has also led some scholars to pay attention to the development of energy education. In explaining the necessity for energy education as an independent discipline, Kandpal and Garg (1999) argue as follows:

> Recently the global phenomenon of climate change primarily attributed to excessive energy extraction, conversion and utilization came to the forefront of international concerns. This has necessitated that energy be considered a very special topic and all its relevant dimensions be studied in considerable detail. Hence the need for establishing a separate educational discipline for energy.

Current scholarly focus, however, is rather on Environmental Education (EE) or Education for Sustainable Development (ESD) and energy is considered one key subtopic under the umbrella of EE or ESD not only in the Asian region, but also globally. For example, energy issues are dealt in two of the four core programmes - 'climate science and knowledge' and 'climate change, ethics, social and human sciences dimensions' respectively - of "Climate Change Education for Sustainable Development" by UNESCO

1) Afghanistan, Australia, Bangladesh, China, India, Indonesia, Iran, Japan, Malaysia, Nepal, New Zealand, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, and Union of Soviet Socialist Republics (Now Russia).

2) These are the key energy sources listed in the 2012 Key World Energy Statistics by IEA.

(2010). Having sustainable development as the big picture for the discussion of energy issues is indeed crucial in order to tackle the issues in an integrated way. Nevertheless, special attention on energy education alone is also important in the Asian region especially in China, Japan, and South Korea which represent 75% of Asia's energy consumption in 2008 (BP, 2009). China, Japan, and South Korea are also big energy consumers globally as they accounted for 27.5% of the total primary energy consumption in the world in 2011, and stood individually at 21.5%, 3.9%, and 2.1%, respectively (BP, 2012). In 2011, China alone accounts for 71% of global energy consumption growth (BP, 2012). Although the shares of Japan and South Korea are much lower than that of China, both these countries have actively pursued the development of nuclear energy for domestic energy use. With no dependable domestic energy sources, Japan and South Korea are largely reliant on the import of fossil fuel energy sources such as coal and oil, and also two of the leading countries in the use of nuclear energy technologies (Tow, 2007) – ranking 3rd and 5th, respectively, globally. However, the Fukushima disaster of 2011 has raised crucial questions regarding the safety of nuclear energy in the region. In short, with the economic development of China, the regional energy consumption is increasing rapidly, and the sustainability of the Japanese and South Korean economies seems to depend on their energy security. Furthermore, these issues are unlikely to be resolved in the near future. Therefore, it is necessary for future stakeholders of the nations, *i.e.*, students and members of the young generation to understand such issues.

As energy issues have been discussed in the regions at least for the last two decades, some extent of energy-related contents must exist in educational curricula and textbooks, because education reflects the political, economic, social cultures of a certain region in a certain time (Apple, 1982b). With this assumption - that there are energy-related contents in curricula and textbooks – this research tests the hypothesis that texts in the current energy education in the three nations reflect the current national

political, economic, and social conditions, especially because a state-driven curriculum, is aligned with each nation's political, economic, and social cultures and traditions (Apple, 1979, 1982a; Beyer & Apple, 1988). The main objective of this thesis is, therefore, to initiate the study of energy education in the three nations' public education sectors through the analyses of their national curricula and textbooks in the light of sustainability. The curriculum of each nation's compulsory education and the qualified textbooks of each country are examined to understand how education in relation to energy is ongoing at the national level. Since each of the three countries has a nine-year compulsory education system that does not cover high school education, curricula and textbooks at the middle school level have been reviewed.[3)]

The critical discourse (or text) analysis method was selected as the primary methodological approach, so as to develop analytical and critical claims to energy education within national educational systems, in the context of sustainability. Critical discourse analysis approach has been adopted in critical theory paradigm research due to its suitability to help researchers analyze the ideologically, politically, or socially shaped meanings of texts (Chambers, 2009). Hence, through critical discourse analysis of the current curricula and textbooks of the three countries, this research attempts to address the pitfalls and possibilities of centralized curriculum and textbook systems in relation to energy education, particularly in the perspective of sustainability. Furthermore, while the study primarily focuses on energy education in public schools, nuclear energy education will also be addressed.

With practical reasons for the importance of energy education in the East Asia region–the focus being on China, Japan, and South Korea–discussed in this introduction section, the remaining structure of the thesis is divided into five major parts: (1) the theoretical background of the study;

3) Regulated by the "Compulsory Education Law of the People's Republic of China," the "Basic Act on Education" in the case of Japan, and the "Education Law" in Korea.

(2) the methodological background and data collection; (3) the findings that consist of three sections, the results of curriculum and textbooks analyses in relation to energy education in general, and the analysis of nuclear education; (4) the discussion of the results in light of environmental education and sustainability; and, finally, (5) the conclusion of the study.

II. **Theoretical Background**

The notion of sustainable development has become common over the last two decades, especially since its mention in the Brundtland Report in 1987.[4] While the discussions on its role in economics, politics, and various other fields remains controversial and continues to expand, it is certain that the discourse of sustainable development has explicitly given birth to a new "green" trend and a negotiation table among various fields. As a result, sustainable development is now commonly accepted as a concept that consists of three equally valued scopes - economy, society, and environment (Moon, 2010; Torgerson, 1999).

However, there is also a critical view that this conceptualization of sustainable development may not allow for a genuine consensus since there is no fundamental agreement about the interrelationships among disciplines (Blewitt, 2008). Because of the definition's ambiguity,[5] some have also argued that there should be more efforts to develop a more reflective concept that embraces more ethical spiritual approaches (Blewitt 2008). In fact, there are some who regard "sustainable development" as merely depicting "sustained growth" or "successful development" (Ratner, 2004), since the term "development" can exclude ecological concerns. As Esteva (1992) notes, "in its mainstream interpretation, sustainable development has been explicitly conceived as a strategy for sustaining 'development', not for supporting the flourishing and enduring of an infinitely diverse natural and social life."

Whether the emphasis in 'sustainable development' is on the former

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4) The well-known definition of sustainable development is "[d]evelopment that meets the needs of the present without compromising the ability of the future generations to meet their own needs (WCED, 1987)."

5) For example, John S. Dryzek (1997) explains how the term sustainable development explained by Brundtland is ambiguous in its concept, and therefore did not win everyone's agreement.

word or the latter, it is obvious that a new understanding of energy is one of the key determinants to achieve either goal. In other words, energy is essential to, and, thus, an inevitable topic in any discussion of, sustainable human life. Studying energy, therefore, means studying nature and people, as "[a] study of humanity and nature [becomes] a study of systems of energy, materials, money, and information (Odum, 2007)."

In an academic discourse, energy issues in Asia are tightly linked with its population growth and its continuous economic development (Tow, 2007; Wu et al., 2007). In a broader perspective, however, these challenges provide the opportunity to reflect on human's changing perspectives on energy, the newly emerging energy responsibilities of humans, and the role of learning or education so as to inspire this reflection. These three themes are congruent with those listed by Gough and Scott (2006) as the three reflective implications of sustainable development.

Hence, this section maps out energy and education related works in the light of sustainability, so as to devise a theoretical framework for the study. This section is thus divided into three parts: the perspectives on energy, the need for ecological citizenship, and the role of learning and education.

1. Perspectives on Energy

As mentioned earlier, White (1943) shed light on the concept of energy in the early 20th century. A great deal of his work was devoted to the significance of energy in the process of the development of human culture. He explained energy's role in the evolution of human culture as follows:

> In the course of human history various sources of energy are tapped and harnessed by man and put to work at culture-living and culture-building. The original source of energy was, as we have

> seen, the human organism. Subsequently, energy has been harnessed in other form-agriculture, animal husbandry, fire, wind, water, fuel.…[I]t makes big difference to human beings where the energy comes from, and an important index of cultural development is derived from this fact.

In developing his interpretation on the role of energy in cultural development, White first explained two dimensions of the need for cultural development. The first one is related to the inner satisfaction of humans which can be attained by the resources within humans, such as by doing artistic or spiritual activities. The second one can only be satisfied when resources are exploited from the external world, such as by utensils and tools used for providing humans with something to eat, wear, and sleep (1943). He stated that the first need from the inner world can be seen as a constant whereas the second one is dependent on variables, i.e., "the material, mechanical means with which man exploits the resources of nature (White, 1943)." He, therefore, focused on the latter version of human culture and continued to explain the five factors of "the articulation-of-man-with-earth process," which are:

1) The human organisms;
2) The habitat;
3) The amount of energy controlled and expended by man;
4) The ways and means in which energy is expended; and
5) The human-need-serving product which accrues from the expenditure of energy

It is possible that because White focused on human's culture, his focus is on the humans' use of energy. Nevertheless, there is a branch of study that views energy from an alternate perspective. For example, an understanding of indigenous knowledge is now gaining attention from experts and scholars, especially in the field of traditional ecological knowledge (TEK). An advantage of TEK perspectives is to compare modern science with indigenous knowledge in the understanding of nature (Berkes et al., 2000). Concerning energy, TEK scholars seem to agree on the concept of energy as a linking component between nature and humanity within a complex ecosystem (Berkes et al., 2000; Odum, 2007). As an example,

Odum (2007), a prominent scholar in the field of ecological engineering, states how a comprehensive understanding of energy could guide how energy and environment are interrelated and their importance in the twentieth century:

> A study of humanity and nature is [·] a study of systems of energy, materials, money and information. Therefore, we approach nature and people by studying energy systems networks. The idea is to use general systems principles to understand and predict what is possible for society and environment. ··· Energy from the sun and from the earth is running the landscape and its links to humanity. The quantity of useful energy determines the amount of structure that can exist and the speed at which processes can function. The small areas of nature, the large panoramas that include civilization, and the whole biosphere of Earth and the miniature worlds of ecological microcosms are similar. All use energy resources to produce, consume, recycle, and sustain.

Putting it another way, White takes an anthropocentric point of view in discussing humans' control over energy, whereas Odum approaches the same from a more holistic orientation, *i.e.*, ecological point of view. As the two scholars' specialties are different, the difference in approaching and understanding the concept of nature can be different. However, an interesting point here is White's acknowledgement that the five factors explain human beings' exploitation of natural resources in/of the habitat, the earth, for the sake of sustainability of life and perpetuation of human kind (1943). Considering the time when this work was written, the current environmental issues could have not been dealt in depth; these should nevertheless be incorporated in today's society, which is suffering from environmental and energy crises. Furthermore, it should be approached based on understanding of the closely woven relationship between energy and environment. In fact, there have been scholarly efforts to develop an alternative, or holistic, notion of discourse with ecological or green approaches (Chambers, 2009). In the same sense, Torgerson (1999) remarks "the green orientation retains significant coherence in its questioning of industrialism and instrumentalism." Indeed, "throwing into question the arrogant assumptions of industrialism," as he describes, "the green movement provokes a reconsideration of the

entire human/nature relationship (Torgerson, 1999).”

However, frequently discussed energy issues do not show an integrated understanding of nature and human relationships and merely regard energy as a necessary means to sustain economic development. The concept of energy is used today, therefore, in its universalized sense, which has become the central interest of many nations in Asia, as the continuous rise in population and the economic development processes often entail energy security and consumption issues as well as environmental impacts.

As a result, the English word “energy,” used to indicate a power-providing source, is also used, without translation, in South Korea. In Japan, the German word “energie” is used without translation, and in China, however, the Chinese word 能 is used to refer energy, which literally means “ability” or “capability.” In other words, it can be assumed that the concept of energy originated in the west in reference to energy driven activities in industrialized societies.

2. The Need for Ecological Citizenship

1) New Responsibility and Obligation

The integrated understanding of nature and of human beings as part of complex earth system in Asia requires the “greening” of its citizens. The term greening today entails multiple meanings, but this paper limits its meaning to taking an ecologically or environmentally critical stance based on an integrated understanding of nature and human relationship. In other words, it is putting sustainability into consideration in the process of decision making. Torgerson (1999) labels such virtue as ecological rationality in his work. This greening process can be realized through the efforts made by both the state and society. Thus, the greening process for citizens and

the space in which citizens exercise their rights to interact on green related knowledge should be given considerable scholarly attention. This leads to the need for new citizenship, and in explaining the reasons for his emphasis on citizenship Dobson (2005) provides theoretical and practical accounts:

> From a practical point of view, governments and their agencies seem slowly to be coming to realize that they cannot create sustainable societies on their own. As the vogue has it, we are moving from 'government' to 'governance', and while this rhetoric offers liberal-capitalist governments the opportunity to row back on the publicly provided elements of their responsibilities (an opportunity they seem only too willing to grasp), it also focuses attention on the role that civil society might play in achieving political objectives. It can be assumed that 'sustainable development' is one of these objectives – broadly endorsed by governments around the world – and that the 'turn to citizenship' implies that citizens as well as governments have a role to play in bringing it about. At the same time, of course, it will always be part of environmental citizens' responsibility to work towards making sure that governments do what they must to provide the context for sustainable behavior.

The notion of green citizenship has given birth to few different concepts of citizenship such as sustainability citizenship, environmental citizenship and ecological citizenship. Sustainability citizenship is discussed in Barry's (2006) work, and the latter two concepts are developed and explained by Dobson's (2003; 2005; 2007) works in detail. From Dobson's (2003) work, it can be understood that environmental citizenship is discussed in the realm of neoliberal and civic republican perspectives whereas ecological citizenship requires the new "post-cosmopolitan" notion due to the transnational characteristics ecological footprints.[6] In this regard, ecological citizenship can also be called post-cosmopolitan citizenship and it is a new notion that regards 'justice' as the principal virtue.

Although the concept of ecological citizenship is in development, it definitely challenges the traditional understanding of citizenship (Sáiz, 2005). For instance, it has characteristics of being global because environmental problems, especially climate change, happen beyond national boundaries,

6) However, the two citizenship concepts are in complementary relations and share the similarity in that both pursue sustainable society (Dobson, 2003).

which requires “a notion of collective responsibility”; and characteristics of being deliberative (Dobson, 2003; Sáiz, 2005). Also ecological citizenship provides historical and moral grounds for “non-reciprocally owed duties of those with bigger ecological footprints (Dobson, 2003).”

In other words, those who extract and consume more energy resources have historical obligations because ecological citizens have the obligation for the means that sustain the lives of future generations as well as that of the non-human organisms. In short, the obligations of ecological citizenship are asymmetrical (Dobson, 2003). As mentioned earlier, China, Japan, and South Korea represent 75% of total energy consumption in Asia and 27.5% of that of the world. The Asian region is consuming more energy than its capacity to produce energy. In order for the Asian region to be sustainable, regional awakening on, and the promotion of, ecological citizenship are necessary. As a strategy to achieve ecological citizenship, Dobson (2003) examines ecological citizenship education in British public education and concludes in his review of “The Education Act 1996” and “Teachers’ Guide-National Curriculum” that the British curriculum is already prepared for environmental and ecological citizenship education.

2) Educational Perspective of Ecological Citizenship

As ecological citizenship is a normative and theoretical notion (Park, 2010), there is always possibility to incorporate the concept into educational perspective. In this regard, ecological citizenship is often discussed in educational fields as one of the goals of education, which can then relate to the notion of action competence (Carlsson & Jensen, 2006). Nevertheless, this is not to shift the responsibility to the students but to provide them with full opportunity to nurture their ecological empathy and to develop the essence of green political thought and competence,[7] as they will eventually

7) For example, Torgerson names the essence of political though in green politics as *ecological rationality* (1999).

become stakeholders of national and global politics. Especially in the Asian region, which faces an energy dilemma, energy-related issues in the context of ecological citizenship should receive scholarly and practical attention.

There are, in fact, a growing number of studies on environmental education in relation to this new concept of citizenship. For instance, Kim (2011) examines the implication of discussion of ecological citizenship in geography education by introducing the concept of ecological citizenship as a notion derived from the tension between the globalized environmental problems and individualized responsibility. Gough and Scott (2006) also examine their empirical ESD experience in the context of environmental citizenship. Carlsson and Jensen (2006) explore the concept of environmental citizenship in the context of action orientation and action competence pedagogical approach, and provide cases from the Danish school context. While all of the studies indicate scholarly efforts towards relating ecological citizenship with environmental education, none of them, unfortunately, adequately addresses energy education in relation to ecological citizenship education.

3. The Role of Learning: From Education System to Text, in Relation to Energy Education

There are few studies on energy education in the Asian region, especially ones that discuss the normative framework of energy education in general. For example, Kandpal and Garg (1999) see energy education as a rising branch of learning and seek to introduce significant features that are essential to be covered in the new discipline. The authors present brief explanations on the objectives of energy education; classification of energy education programs; important energy issues within developing countries; desirable features of energy education programs; curriculum development for

the discipline; the relationship between energy and environmental education; and the issues with regard to consistency among different energy education programs. These elements, according to the article, are discussed to answer some fundamental issues that the authors mention in the beginning of their discussion. The fundamental issues are as follows (Kandpal & Garg, 1999):

1. Assessment and evaluation of manpower requirements in the field of energy.
2. Identification of inputs required to be given to the students at different levels, so meeting different job requirement.
3. Integrating relevant inputs in the overall course curricula, so ensuring a holistic approach to energy education.
4. Design, development and implementation of specialized courses on energy for technicians, mechanics, engineers, etc.
5. Ensuring synergy between the energy and environment education.

Given the fact that the field of energy education has received relatively little attention when compared with other facets of environmental education, such as education for sustainable development, the authors' effort to collect and organize relevant issues regarding energy education can contribute to further studies and research. Especially, the suggested fundamental issues and the objectives of an energy education program provide a theoretical basis for relevant studies. In terms of education, what is significant in this paper is that the authors put emphasis on students' awareness, skills, and appreciation of energy-related issues rather than the delivery of certain knowledge when dealing with the objectives. This is possibly because energy education is, and should be, in accordance with the purpose of environmental education that ultimately aims at developing environmental or ecological citizenship within a society.

Furthermore, there are a few studies on renewable energy education, which normally focus on renewable energy education at the higher secondary level (Jennings & Lund, 2001; Thomas et al., 2008). For example, a relatively recent study by Thomas et al. (2008) collected available courses at the undergraduate and postgraduate level in Australia and New Zealand and concluded that the skills shortage, accreditation, content, lack of textbooks, linking teaching research and development, and

research funding were the challenging issues in renewable energy education at the moment. Unfortunately, there is no established scholarly discussion about energy education in East Asia where the education is urgently needed. Academic and political discussions at the international level are essential for achieving regional and international cooperation towards complex global energy issues.

All of the above discussed researches take pedagogic approaches and are valued work. However, these works do not provide enough attention to the discussion of the educational system in approaching energy education. Before pursuing a content-based approach, some essential facts about the education system and conditions that create educational contents should be observed. In China, Japan, and South Korea, compulsory education covers nine-year education for every child, and the education is based on the national curriculum. The reason for the presence of a national curriculum is to convey nationally and globally promoted values for citizens (National Institute for Educational Research (henceforth, NIER) 1999).

With global environmental concerns, many countries encourage environmental awareness and related knowledge including in China, Japan, and South Korea. For example, it is explained "[t]he national curriculum is revised on a periodic basis to reflect the newly rising demands for education, emerging needs of a changing society, and new frontiers of academic disciplines" on the official website of the Ministry of Education, Science and Technology of South Korea.[8] In the case of China, the contents of the new curriculum named "New Basic Education Curriculum" define some relevant objectives such as the "development of healthy world outlook, life outlook and values" and the "cultivation of creative spirit, capability of practice, scientific and humanistic competencies, and environmental awareness (Zhou & Zhu, 2007)." Japan is not an exception. One of the five objectives of education as stated in Article 2 of the Basic Act on Education is "to foster an attitude to respect life, care for nature,

8) Retrieved from http://english.mest.go.kr/web/1693/site/contents/en/en_0203.jsp

and contribute to the protection of the environment."

The advantage of possessing a highly centralized education system is that it accelerates the spread of certain knowledge that needs to be shared by everyone. This is probably why Dobson (2003) reviewed national education in the context of ecological citizenship rather than developing new methodology or pedagogy.

On the other hand, a national curriculum is often accompanied by embedded ideology pursued by a state (Apple, 1979; Beyer & Apple, 1998). This is presumably due to "the role school curricula played in the creation and recreation of the ideological hegemony of the dominant classes and class segments of [a certain] society (Apple, 1982b)." Apple (Apple, 1979) also remarks, " [···] it is very difficult for educational and social theory to be neutral. [···] Curricular and more general educational research needs to have its roots in a theory of economic and social justice, one which has as its prime focus on increasing the advantage and power of the least advantaged." Since energy-related issues are actively discussed in the economic market and the political arena, each stakeholder, *i.e.,* corporations and the state, must have different understanding of, and interest in, the issues. Hence, when a curriculum is designed and developed by governmental agencies like in China, Japan, and South Korea, the economic and political interests of certain groups might also be incorporated. Furthermore, when textbook systems are also controlled by a government, knowledge within textbooks also becomes legitimate rather than being neutral (Apple 1986; 1992; Apple & Christian-Smith, 1991).

For example, Apple (1991; 1992) identifies a role of textbooks in making school curriculum legitimate knowledge rather than neutral knowledge. This discussion stems from the author's cultural-political understanding of education. In other words, the author regards education and power as binding concepts and, therefore, regards textbooks as the reflection of such relationship. According to Apple's (1992) argument, they can be seen as "the simultaneous results of political, economic, and cultural

activities, battles, and compromises [that] are conceived, designed, and authored by real people with real interest," as textbooks represent so called *selective tradition*. As an instance, Apple (1992) explains how Japan's right wing history textbook that positively depicts the invasion of China and Korea has caused international controversies.

This is not to argue against the national curriculum system and textbook system. Nevertheless, it is necessary to note that education and schooling are different. As Lemke (1995) notes the fundamental purpose of schools is "to teach the literacy code," which is "generally taught in relation to specific, highly valued written texts which embody dominant cultural values and socially useful knowledge and discourses." On the other hand, to educate someone is to enable him or her to think independently. The objective of education, therefore, is the ultimate development of oneself based on one's autonomy and critical thinking (Jickling, 1992). In other words, the literacy code taught at schools is meant to help students develop their critical thinking and not to manipulate them with designed contents. In this regard, Apple's insight on text and national curriculum is also very relevant for environmental education and education policy making fields, because it allows for weeding out culturally and socially designed knowledge, or legitimate knowledge, and to read real messages. In particular, his approach to textual analysis provides a sound theoretical framework for research on the relationship between the current environmental policy and nationally driven public education. Furthermore, Lemke (1995) also highlights that having specific target group texts cannot be free from "value preferences"; hence, the importance of the linkage between social and physical environments. As climate change has become a global concern, or "interest", almost every nation approaches the concern with its strategies which reflect its social, political, and economic cultures. This mainstream culture can, in turn, influence the public education of a certain country. The comprehension of political economic characteristics of education, or of the functions of schools, is a crucial task in the field of

environmental education, because environmental education should aim at helping students develop their competence or ecological citizenship with the integrated understandings of the complex relationship between nature and humans.

Apple's approach, *i.e.*, analyzing textbooks by illuminating power relations, will help researchers in the field of environmental education or environmental policy to discover where to begin the establishment of unbiased environmental education. Nonetheless, as experts highlight (Apple, 1992; Chambers, 2009), there can be multiple readings for any text and textbooks are not everything in the real educational settings. The roles of teachers, students' interpretations, and educational environment are all valued factors. Nevertheless, it is still important to investigate what is written in curricula and textbooks especially in the nations where textbooks entail significant meanings such as in China, Japan, and South Korea. Indeed, the textbooks in these three countries are regarded as the *bible* both for students and teachers (NIER, 1999; Korean Institute for Curriculum and Evaluation (henceforth, KICE), 2011).

Having framed the theoretical context, the discussion now turns to the explanation on data collection and methodological background.

III. Methodological Background

In the case of the three selected nations, they are the most frequently mentioned countries with regard to highly centralized curriculum and textbook systems. Pingel (2010) points out that it is important to examine the background of a curriculum and the aspects of curriculum teaching as a preliminary analysis before textbook analysis. Therefore, data for this research includes both the curriculum and textbooks of China, Japan, and South Korea, and what is followed in the current systems of curricula and textbooks in the three nations. Additionally, there is a recognition that a theoretical background, *i.e.*, particular school of thought or theory, and methodological approach should be in line with each other due to their "inevitable interwoven" characteristics (Chambers, 2009). As this study focuses on the critical analysis of textbooks to examine the political and economic implications of the texts, critical discourse analysis is selected as a major methodological approach for the study. This approach also satisfies Pingel's (2010) argument that "the findings of textbook analysis should be compared with those of academic research and debate." In this regard, the summary of the collected data and the explanation on methodological approaches are presented in this section.

1. Data Collection

1) Current Curriculum and Textbook Systems

Recent curriculum studies explain that educational goals and policies, which are usually in line with each country's social, economic, political, and cultural contexts, are well reflected in the curriculum

framework of their compulsory education sectors (NIER, 1999; KICE, 2011). China, Japan, and South Korea share similarities in terms of their curriculum policies and curriculum development processes. For example, these countries are known to have a high degree of curriculum regulation at a national level (NIER, 1999). The curriculum development processes, in particular, are highly centralized, although some degree of flexibility at the local or school level is encouraged. The table below summarizes the governmental agencies and stakeholders who are involved in the curriculum development in each country (NIER, 1999).

[Table 1] List of agencies involved in the curriculum development

Nation	Agency initiating and overseeing curriculum development	Agencies consulted
China	Ministry of Education	Professional editors, colleges and universities, teachers, students parents, other professionals
Japan	Ministry of Education, Culture, Sports, Science & Technology	Central Council for Education (broad aims), Curriculum Council (curriculum guidelines), committee for making the course of study
South Korea	Ministry of Education and Human Resources Development	Research institutes (e.g., Korean Education Development Institute and KICE), various groups (e.g., teachers, parents, students, industry, academic associations)

The textbook development, provisioning, and publishing processes in three countries also share similarities in terms of the state-based centralized system. The table below summarizes textbook policies in each country (KICE, 2011).

[Table 2] Textbook policies in China, Japan, and South Korea

	Legal basis
China	Compulsory Education Law which includes national screening system

Japan	School Education Law, Institution of free-of-charge textbook supply
South Korea	Elementary and Secondary Education Law Article 29, Section 1 and 2

Furthermore, regardless of the kind of textbook issue system, textbooks are generally seen as a reflection of the national curriculum designed for schooling (NIER, 1999; KICE, 2011; Apple, 1996). Textbooks have played a role not only as a central tool for schooling, but also as a tool for reflection on the tradition and the cultural contexts of a certain country (NIER, 1999). The meanings of the Chinese, Japanese, and South Korean textbooks as identified through earlier studies may be summarized as follows: first, the textbooks reflect the national educational curriculum, and second, the textbooks of public education are positioned as the basis of education such that they function as sacred books or bible for both teachers and students (NIER, 1999; KICE, 2011).

Therefore, the curriculum development systems and textbook policies are structurally analogous to each other in three countries in the sense that they are highly centralized and textbooks are the reflection of national curricula. Having outlined the structures of curricular and textbook systems in general, the focus now turns to the selected data.

2) Selected Data

Based on previous research and information provided on official websites of each governmental agency,[9] the current editions of national curricula are listed in the table below.

9) http://www.moe.edu.cn (Ministry of Education, China), http://www.mext.go.jp (Ministry of Education, Culture, Sports, Science & Technology, Japan), and www.mest.go.kr (Ministry of Education, Science and Technology, South Korea)

[Table 3] Current editions of national educational curricula

	Current edition of curriculum
China	The 2011 Edition of Compulsory Education: Subject Specific Curriculum Standard (effective from September 2012)
Japan	The 2008 Edition of (legally binding) Teaching Guideline
South Korea	The 2007 Revised National Curriculum, which is known to be the 4th partial revision of the 7th Curriculum

In the case of Japan and South Korea, the textbooks are qualified for use in schools after passing a qualification screening by an applicable institution as mentioned earlier. Therefore, in Japan and South Korea, textbooks which have passed the central government qualification process have been selected as the research data. The textbooks in China also must go through government screenings and qualifications in order to be published, and the Ministry of Education announced its textbook selection policy in 2003, where it is stated that each province or local government institution must select textbooks which are published by three different publishing companies or more. As a result, more than 80 publishing companies are currently involved in the textbook industry, and open competition in the textbook market is common in China. However, the People's Education Press (人民教育出版社) still has control over 50% of the textbook market (KICE, 2011), and it is difficult to collect and analyze textbooks published by more than 80 publishing companies. Consequently, in this study, the textbooks of the People's Education Press have been selected as the representative Chinese textbooks.

Based on the listed curricula, a preliminary search for energy-related contents was conducted, and it was found that social studies and science are commonly the subjects with energy-related contents. Then, textbooks of social studies and science subjects were collected.

In short, middle school social studies textbooks, with the exception of history textbooks, and science textbooks of all publishers have been

collected from Japan and South Korea, and the People's Education Press's social studies textbooks and science subjects' textbooks are collected from China. [Table 4] below lists the various subjects of the collected textbooks.

[Table 4] Titles of subjects for the collected textbooks

	Social Studies	Science
China	History and Society, Geography, Thoughts and Morality	Physics, Chemistry, Biology
Japan	Geography, Civics	Science
South Korea	Social studies	Science

In the examination and selection process, a total of 111 textbooks (23 from China, 26 from Japan, and 62 from South Korea) have been reviewed and 46 have been finally selected as those with content pertaining to energy-related content. [Table 5] below lists the subjects that contain the pertinent material.

[Table 5] Subjects with energy-related contents

	Social Studies	#of textbooks	Science	#of textbooks
China	History and Society, Geography	2	Physics (grade 8 and 9), Chemistry (grade 9)	3
Japan	Geography Civics	7 4	Science (grade 8 and 9)	10
South Korea	Social Studies (grade 9)	11	Science (grade 9)	9

2. Methodological Approaches

According to the *UNESCO Guidebook on Textbook Research and Textbook Revision* (Pingel, 2010), comprehensive methodological approaches for in-depth textbook analysis include analysis of both the general structure and the arrangement of the lessons. The focus of this study, however, is not the analysis of a whole textbook since there are no separate textbooks for energy education in the compulsory education sectors in the three countries. The focus is rather on text and discourse within text. In other words, how energy-related texts are written, and the explicit and implicit implications of the texts are examined.

First, in order to understand the context how texts are allocated, the titles of units and sub-units are summarized; and to understand how the important terms are defined within the units, explanation on each term is excerpted.[10] In analyzing excerpted and summarized texts, critical discourse analysis (CDA) approach is adopted so as to specify the implicitly embedded ideology within texts (Cho, 2009). CDA fits best for the theoretical understanding of this study in that it sees texts as objects to be analyzed so as to interpret the political economy or socio-historical conditions behind them (Fairclough, 1992; Janks, 1997; Luke, 1995).[11] CDA has originated in a critical theory of language that regards the use of language as "reflection of social practice" (Hyland & Paltridge, 2011; Janks, 1997). In this regard, this method is focused on linguistic characteristics of text, especially when following Fairclough's idea. For example, he distinguishes his method of "textually oriented discourse analysis" from that of Foucault, as linguistic approaches are not really a favorite of the latter branch (Fairclough, 1992). Although this study rests more on Fairclough's

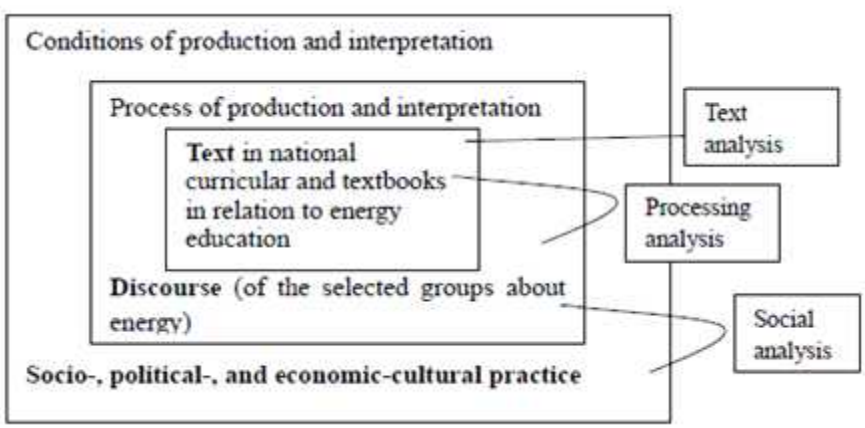
10) In the process of screening, all the textbooks were scanned as searchable PDF files and the key word "energy" was searched.

11) As discussed earlier, this study draws on Apple's understanding of education that it is not so dissociated with the politics of culture (Apple, 1996). Therefore, national curricular and textbooks are seen as productions of selected knowledge rather than neutral knowledge.

idea that takes more a social scientist's approach, some linguistic issues and Fariclough's ideas on analysis will also be dealt with for the purpose of examining how texts position students in relation to energy education. Also Fairclough's three interrelated dimensions of discourse (Fairclough, 1985; 1989; 1992; Janks, 1997) are relevant in terms of building the methodological framework of the study. In Janks' words the three dimensions are (1997):

1. The object of analysis (including verbal, visual or verbal, and visual texts)
2. The process by which the object is produced and received (writing/ speaking/ designing and reading/ listening/ viewing) by human subjects'
3. The social-historical conditions that govern these processes

Furthermore, these dimensions should be analyzed in three different kinds of analyses, which are: text analysis, processing analysis, and social analysis (Fairclough 1989; Cho, 2009; Janks, 1997). As the objects of this study are curricula and textbooks, Fairclough's three dimensions of discourse and discourse analysis can be illustrated as [Figure 1].



[Figure 1] Methodological framework of the inquiry (*Note*. Adapted from Fairclough 1995; Janks, 1997)

As this method is suitable for critical and problem-oriented study, there is no concretely given position for both the theoretical and methodological approaches (Hyland & Paltridge, 2011). Rather "the CDA

research process begins with a research topic that is a social problem. ⋯ Methodology is the process during which, informed through theory, this topic is further refined so as to construct the objects of research. ⋯ The choice of appropriate methods depends on what one is investigating [or questioning] (Hyland & Paltridge, 2011).”

In reviewing CDA, Janks (1997) raises next questions with regard to texts: *How is the text positioned or positioning? Whose interests are served by this positioning? Whose interests are negated? What are the consequences of this positioning?* As a reminder of the theoretical background of the study, the questions are answered in Apple’s (1992) words, which are intimately linked with each other:

> Th[ese are] distinct problem[s] since texts are not simply "delivery systems" of "facts." They are the simultaneous results of political, economic, and cultural activities, battles, and compromises. They are conceived, designed, and authored by real people with real interests. They are published within the political and economic constraints of markets, resources, and power (Luke, 1988, pp. 27-29). And what texts mean and how they are used are fought over by communities with distinctly different commitments and by teachers and students as well.

By incorporating such approaches with regard to energy education, the following questions can be raised: *How is the energy-related text positioned or positioning in nationally designed textbooks? How are the authored interests served by this positioning? Whose interests are negated? What are the consequences of this positioning? How are the students considered in the process?*

Texts, of course, cannot provide complete explanations of a certain discourse; rather, the analysis of the text can accelerate chances for further CDA (Janks, 1997). Therefore, this research also aims at conducting the inquiry as the starting point of related research by answering the questions above.

Because a large part of the objects of the study is textbooks, some quantitative methodological questions are also possible as comprehensive textbook analysis usually consists of both quantitative and qualitative methods (UNESCO, 2011). The possible quantitative questions for the study

are: "*How many times is a term related to energy used or mentioned?"* and "*How much space is allocated to the relevant topic?"*

In short, this study seeks to find and compare the political economy of texts presented in the national curricula and textbooks of China, Japan, and South Korea mainly relying on critical discourse (text) analysis method with some amount of qualitative analysis. Ultimately, with the analysis results the present work questions whether ecological citizenship can be achieved in the current national education environment. In sum, the chief questions raised in this section are as follows:

1) How many times is a term related to energy used or mentioned?
2) How much space is allocated to the relevant topic?
3) How is the energy-related text positioned in nationally designed textbooks?
4) How are the authored interests served by this positioning?
5) Whose interests are negated?
6) What are the consequences of this positioning?
7) How are the students considered in the process?
8) Is ecological citizenship or competence an desirable educational aim in the current educational setting?

IV. **Results**

1. Curriculum Analysis

1) Science Subject

The current editions of curricula for the science subject from all three countries contain energy-related contents. In the case of China, “Science, Technology, Society, and Environment” is not only one of the four dimensions of the science education, but is also one of the key themes. In this regard, science subject textbooks also include a “Science, Technology and Society” (STS) section which reflect the overall goal of the science education in China. Nevertheless, energy-related contents are not discussed in the section; energy-related section is taught under the theme of Material Science.

In case of Japan, the curriculum is divided into two categories: the First Section and the Second Section. Energy-related content is included in the First Section, under the theme of “Science, Technology, and Humans.”

The curriculum of science in South Korea is also divided into two categories: Material and Energy, and Life and Earth. Among the two divisions, the energy-related contents are treated in the first category. Each key theme in the curriculum with the energy-related contents is summarized in [Table 6].

[Table 6] Key themes of science education in the curricula

	Key themes of middle school science education (**bold**=themes with energy-related contents)
China	I. Deep study of Science (科学深究) II. Life Science III. **Material Science**

	IV. Earth and the Universe V. Science, Technology, Society, and Environment
Japan	(The First Sphere) I. Familiar physical phenomena II. Materials around us III. Current and its use IV. Chemical change and atom-molecule V. Motion and energy VI. Chemical Change and Ion **VII. Science, Technology, and Humans**
South Korea	(The First Sphere) I. Force and Motion II. Heat and Our Life III. The motion of molecule and the change of state IV. The structure of Materials V. Light and Wave VI. Properties of Materials VII. **Work and Conversion of Energy** VIII. **Electricity and Magnetism** IX. Rules in Chemical Reaction X. Various Chemical Reactions

When looking at specific subtitles of each theme that contains energy-related contents, in case of China, under the theme of Material Science, it is titled “Energy and Energy Source”[12] which is again divided into two parts: (1) Energy Conversion and Conservation, and (2) Energy Source and Society. In Japan, on the other hand, energy education is not dealt in the material-related part but in the part that discusses the relationship between Science, Technology, and Humans, which again has three parts: (1) Energy, (2) The Development of Science and Technology, and (3) The Conservation of Natural Environment and the Use of Science and Technology. In case of South Korea, energy-related contents are included in two themes which are: (1) Work and Conversion of Energy, and (2) Electricity and Magnetism.[13] All areas within science subject with

12) The subtitles are 1) Often observed material, 2) Structure of material, 3) Motion and interaction of material, and, finally, 4) Energy and energy sources.

13) The Korean curriculum has the most detailed contents and further explanations on energy-related contents are also provided. In the Work and Conversion of Energy part, for example, two energy-related goals are explained as “to know various kinds of energy and their properties such as light energy, heat energy, electric energy, sound energy, new and renewable energy, and to understand the important role of energy for the human future.” Another theme – “Electricity and Magnetism” – covers electric energy and the conversion of

energy-related contents are summarized in [Table 7].

[Table 7] Areas within Science subject themes, with energy-related contents

	China	Japan	South Korea
Theme	**Material Science**	**Science, Technology and Humans**	**Work and Conversion of Energy**
Title	*Energy and Energy Source*	*Energy*	**Electricity and Magnetism**
Subtitle	Energy Conversion and Conservation Energy Source and Society		

Based on the curriculum analysis, it is clear that energy-related contents are differently categorized in each country. When only looking at the themes, titles, and subtitles, however, in case of China and Japan, the terms “society” and “human” indicate that energy science is treated with a certain type of social perspective, whereas South Korea focuses on energy from matter-related perspective.

2) Social Studies Subject

In the curricula of social studies subjects, energy-related contents are often discussed in the areas where resource issues are dealt. In this regard, “energy resource” appears more frequently than the word “energy”. [Table 8] shows the key themes of social studies education with energy-related contents.

energy for the use in households in the relation with energy consumption.

[Table 8] Areas within social studies subjects with energy-related contents

	Headings for relevant sections	
China	(In case of China, there are only units with resource-related contents, and "energy" is never mentioned.)	
Japan	Geography Various areas of Japan	Civics We, and International Society a Various Tasks
South Korea	Geography part The development and use of resource	General Social Science part (None)

In Japan's case, one of the three key parts of the theme "Various Areas of Japan" of geography subject is 'Resource-Energy and Industry' which aims at comprehending the status quo of Japan's resource-energy consumption in the global perspective as well as the trend of domestic energy industry, and at explaining the characteristics of Japan's resource-energy in terms of acknowledging the tasks related with environment and energy. In the civics part, the fourth part of the theme "We, and International Society and Various Tasks" contains two main parts: (1) World Peace and the Improvement of Human Welfare, and (2) Aiming at a Better Society. In the part on 'World Peace and the Improvement of Human Welfare,' it is written that it is important to have economic and technological cooperation in order to solve global problems such as environment, resource-energy, and poverty.

South Korea's social studies curriculum divides the content into two parts which are geography part and general social studies part, even though they are taught in one subject called social studies. Within the two parts, energy-related education is dealt in the Development of Resource and Use section of the geography part, and the detailed contents are as follows:

1) To know the kinds of energy resource, and study the characteristics of use and problems in the aspect of sustainability.
2) To understand the geographic maldistribution of resources (e.g.,

water and oil) and be able to figure out the competition and conflict among nations based on example cases.
3) To take a nation with abundant resource as an example to grasp how the resource influenced the lives of local people.
4) To investigate successful stories of new and renewable energy use, and to become able to understand the condition and directions of our country's new and renewable energy development based on geographic characteristics.

It can be summarized that even though energy education is not dealt as an independent discipline, it is dealt in both science and social studies education. It also seems that science subject and social studies subject display differences in terms of themes of related knowledge. In case of science subject, energy-related contents are dealt in relation to the scientific understanding of materials or technology and human's use. On the other hand, energy-related contents in social studies curricula are dealt in the sections where international and national resource problems are discussed. Also, the need for new and renewable energy source is emphasized in social studies curricula.

2. Analysis of Textbooks

The analysis of curricula shows where energy-related educational contents are placed. Textbooks have specific headings for the relevant units, which more clearly show the categorization of energy-related knowledge in each country's textbooks. Therefore, this section explores the organizations of the relevant themes in each science and social studies textbook through the headings of each chapter or sub-chapter that contains relevant contents, and relevant sentences that explain key concepts in the textbooks are directly excerpted and discussed. Before the examination of the textbook organizations and specific contents of energy-related education, however, a brief analysis of frequency and space allocation is discussed.

1) Brief Analysis of Frequency and Space Allocation

As noted earlier, comprehensive textbook analysis usually conducts both quantitative and qualitative analysis (Pingel, 2010). As the focus of this study is on texts rather than textbooks, however, not much of quantitative analysis is conducted. Nevertheless, it is important to analyze how often and how much energy-related education is positioned in the science and social studies textbooks.

In the process of the analysis, the term ‘energy’ was searched in the body of a textbook, excluding explanatory readings and index pages in a textbook. Also, in the case of Japan, only grade nine science textbooks were selected, because grade eight science textbooks only briefly mention electric energy; this is explained in detail in the in the textbook analysis section.

Through the analysis of frequency and space allocation of energy-related content, it was found that the term ‘energy’ is more frequently mentioned in science textbooks, often with a full unit allocated to its discussion, whereas energy-related content in social studies textbooks is discussed only in one or two sub-sections of a unit. This result implies that energy-related knowledge is often approached by scientific perspectives in the current education environment in the three nations

The tables in the next two pages show the frequency and space allocation of energy-related information.

[Table 9] Frequency and space allocation of energy-related contents in science textbooks

China		Subject A			Subject B			Subject C		
	Page Numbers	166			149			115		
	Frequency of the term 'Energy'	275			27			64		
	Space Allocation for Energy-related content	One Unit			A sub-section of a unit			Two sub-sections of a unit		
Japan		A Publisher		B Publisher		C Publisher		D Publisher		E Publisher
	Page Numbers	132		151		141		174		120
	Frequency of the term 'Energy'	256		265		237		286		223
	Space Allocation for Energy-related content	One Unit		One Unit and a sub-section of a unit		One Unit		One Unit and a sub-section of a unit		One Unit and a sub-section of a unit
South Korea		A Publisher	B Publisher	C Publisher	D Publisher	E Publisher	F Publisher	G Publisher	H Publisher	I Publisher
	Page Numbers	395	393	383	377	427	395	415	415	391
	Frequency of the term 'Energy'	128	163	260	240	223	229	189	223	205
	Space Allocation for Energy-related content	One Unit and a sub-section of a unit	One Unit and two sub-sections of a unit	One Unit and a sub-section of a unit	One Unit and a sub-section of a unit	One Unit and a sub-section of a unit	One Unit and a sub-section of a unit	One Unit and a sub-section of a unit	One Unit and a sub-section of a unit	One Unit and two sub-sections of a unit

[Table 10] Frequency and space allocation of energy-related contents in social studies textbooks

Japan	**Geography**	A Publisher		B Publisher		C Publisher		D Publisher	
	Page Numbers	275		293		265		249	
	Frequency of the term 'Energy'	14		14		20		11	
	Space Allocation for Energy-related content	A sub-section of a unit		A sub-section of a unit		A sub-section of a unit		A sub-section of a unit	
	Civics	A Publisher	B Publisher	C Publisher	D Publisher	E Publisher	F Publisher	G Publisher	
	Page Numbers	211	213	229	195	193	186	181	
	Frequency of the term 'Energy'	10	12	18	14	18	14	15	
	Space Allocation for Energy-related content	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	

South Korea		A Publisher	B Publisher	C Publisher	D Publisher	E Publisher	F Publisher	G Publisher	H Publisher	I Publisher
	Page Numbers	263	267	245	207	241	245	247	256	249
	Frequency of the term 'Energy'	51	34	51	35	43	37	56	57	38
	Space Allocation for Energy-related content	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit	Two sub-sections of a unit

2) Analysis of Science Textbooks

The examination of science textbooks of the three countries shows that most of the energy-related contents are presented in depth in the third grade middle school textbooks. In addition, the textbooks discuss the safe and efficient use of electric energy in their sections on electricity with the Chinese and Japanese textbooks discuss energy-related issues, including diverse energies along with the idea of sustainable development, while Korean science textbook looks at energy only from a material perspective. The table below provides the list of science subjects with energy-related contents. A more detailed discussion of the analysis follows.

[Table 11] Science subjects with energy-related contents

	Subjects with Energy-related Contents
China	Physics (grade 8 and 9), Chemistry (grade 9)
Japan	Science (grade 8 & 9)
South Korea	Science (grade 9)

① China

The Chinese curriculum, unlike that in South Korea and Japan, separates science subjects into Chemistry, Physics, and Biology. Energy-related information is presented in the ninth grade' chemistry volume one textbook, the eighth grade physics volume two textbook, and the ninth grade physics textbook. The ninth grade chemistry volume one textbook has no separate section on energy but mentions energy in the sections explaining air pollution, carbon dioxide issues, and fuels. These sections describe the kinds of energy gained from chemical reactions and emphasize the finiteness of energy, as follows:

> Protecting the air: Clean air is very important for mankind, other animals, and plants. However, with industrial development, harmful industrial gases emitted into the atmosphere and smoke in the air have caused air pollution. Contaminated air can cause serious damage to human health; affect crop growth; and destroy the ecological balance. Global warming, the depletion of the ozone layer and acid rain are all related to air pollution. In order to make the sky cleaner and protect the air, humans now carry out positive actions, such as strengthening air quality monitoring, improving environmental conditions, using clean energy, planting trees and grasses, etc. (9th Grade Chemistry, Volume 1, p. 30)

> The amount of carbon dioxide in the atmosphere is relatively stable. In recent decades, however, due to a sharp increase in human energy consumption and forest destruction, the carbon dioxide level is increasing in the atmosphere. (9th Grade Chemistry, Volume 1, p. 117)

> We refer the fuels that are often used in daily life — coal, oil and natural gas — as fossil fuels, because they are formed by a series of complex changes of the remains of ancient organisms. Fossil fuels are non-renewable energy. (9th Grade Chemistry, Volume 1, p. 131)

> At present, the energy that humans obtain through chemical reactions is mostly from fossil fuels, while fossil fuel resources are limited. Accordingly, the control of combustion of fuel to achieve full potential is very important for energy conservation. If we can improve the utilization rate of the combustion of fuels such as coal, it is equivalent to extending the period of use of coal and other fuel resources. (9th Grade Chemistry, Volume 1, p. 137)

> Humankind's demand for energy is increasing and the energy provided by chemical reactions can no longer meet our needs. Currently, people are using and developing alternative energy sources such as solar energy, nuclear energy, wind energy, geothermal energy, and tidal energy. The use of these energy sources can be a partial solution to the issues faced by depletion of fossil energy and can reduce environmental pollution. (9th Grade Chemistry, Volume 1, p. 145)

In the eighth grade physics volume two textbook, there is a section on electricity contains information on electric energy. Most of the relevant texts emphasize the close relationship between human life and electric energy

> Humanity today cannot be separated from electric energy. Around us, there are a variety of power plants – thermal power, hydroelectric power, wind power, solar power, as well as a wide variety of batteries which convert different energies into electric energy – that are used for a variety of industrial purposes and for everyday life. Electricity is in our service at all times. Wherever you go, you can see electric power at work: the light bulb converting electric energy into light energy, providing us illumination; motors turning electrical energy into kinetic energy, making the fan rotate and moving electric locomotives; electric heater turning electric energy into heat and heating water, chicks in electric incubators hatch, ⋯ televisions

> and computers rely on electric energy work and provide us all kinds of information after processing... artificial satellites rely on solar panels that convert the solar energy into electrical energy to provide to the satellite's devices ···. (8th Grade Physics, Volume 2, p. 38)

The grade nine physics textbook has the most energy-related contents in its section titled "Energy and Sustainable Development." Within this section, five sub-sections — general categorization of energy, nuclear energy, solar energy, energy revolution, and energy and sustainable development — are presented. The selective explanations in the sub-sections on nuclear energy and solar energy in relation to sustainable development show the designed interests. Also in the sub-section on energy revolution, the term revolution explicitly shows the nature of the discourse on energy. Below are excerpts from the sub-section on the general categorization of energy that show the nature of the discourse:

> Energy Family: Coal, oil, and natural gas that we use today are formed by plants and animals buried millions of years ago, that went through long geologic ages, so they are called fossil energy. Like fossil energy, wind energy, solar energy, geothermal energy, and nuclear energy are directly obtained from nature. Energy that is obtainable directly from nature is referred as primary energy.
> Electric energy that we use cannot be directly obtained from nature but must be derived from primary energy consumption, so electric energy is called secondary energy. While living, humans also make extensive use of the chemical energy stored in food and other vital substances. This kind of energy provided by living matter is called biomass energy. In case of fossil energy and nuclear energy, the more you use, the less they become, which means it is impossible to be replenished from nature in the short term, so they belong to the category of non-renewable energy. The kinetic energy of water, wind energy, solar energy, and biomass energy can be continuously obtained from nature, so they belong to the category of renewable energy (9th Grade Physics, p. 148-149)

The sub-section on nuclear energy contains basic explanations of atoms, atomic nuclei, nuclear energy, nuclear fission, and nuclear fusion. As mentioned earlier, the analysis of the texts on nuclear energy is discussed separately in the results section of this thesis. The sub-section on solar energy describes the importance of solar energy from various perspectives,

including historical, biological, and technical, as follows:

> Of the energy that the sun radiates, only about one part of 20 million (1/20 million) is delivered to the Earth, and of this less than half is received by Earth. Sunlight has shone on our planet for 50 million years. Earth has, during these 50 million years, accumulated this solar energy, which comprises most of the energy source we use today.
> Taking fossil energy as an example, coal, oil, and natural gas are the most important primary energy sources that the Earth provides to humankind. Both terrestrial and marine plants in ancient times turned solar energy into chemical energy through photosynthesis. After their death, the bodies of these plants were buried in the ground and under the sea and decomposed. After millions of years of deposition and chemical changes; through stratigraphic movements; and under high pressure these plants gradually turned into coal and oil. During the formation of petroleum, natural gas is also released. Today, our exploitation of fossil fuels to get energy is actually the exploitation of solar energy received by the Earth hundreds of millions of years ago. (9th Grade Physics, p. 155)
> The use of solar energy: In addition to the indirect use of solar energy stored in fossil fuels, humans also manage to directly use solar energy. There are two kinds of the direct use of solar energy: one is to use a collector to heat water and others, and the other one is to use solar-cells to convert solar energy into electricity.
> The surface of a flat plate (solar) collector is glass, with a blackened inner surface. When compared with the temperature outside the box, the inside temperature is100°C - 200°C higher, so the water flowing inside collector pipe collects heat. ··· Solar cells can convert solar energy into electrical energy for our use. The cost of a solar cell is relatively high while the voltage generated in each solar cell is low, which results in its use only in the aerospace industry. In daily lives, it is only used in calculators, watches that consumes low power with low operating voltage. (9th Grade Physics, p. 157)

In the sub-section on energy revolution, the use of firewood as the primary energy is claimed as the representative of the first energy revolution, and fossil energy is mentioned as the primary energy of the subsequent energy revolution. Nuclear energy is then discussed as the representative of the third energy revolution. This is shown in the excerpts below.

> Solar energy, wind energy, and geothermal energy etc. are usually needed to be converted to be useable. Energy conversion technology has continuously advanced in human history, which is called as ‘energy revolution’. The energy revolution has led to a leap of the human civilization. We look at the course of human civilization and progress along the trajectory of the energy revolution. Ancient humans and other animals could also only take advantage of the natural energy source that sun bestowed - Solar Energy.

> The drilling technique to make fire was the earliest technological revolution in terms of energy conversion. From the use of natural fire to the artificially generated fire, it led to the era of firewood as the main energy. This is the first human energy revolution. With respect to the population at the time and productivity, firewood was a renewable energy with a huge quantity and convenient access. The era in which humans regard firewood as the main energy lasted nearly a thousand years. Today, firewood is a still important vital energy in some developing countries.
> The invention of the steam engine was a new milestone in the human use of energy. Mankind now gradually replaced human and animal power with massive mechanical power, and it led directly to the second energy revolution. The primary energy source of humans changed from firewood to coal, oil, natural gas and other fossils through energy conversion. This energy revolution started from the mid-18th century and caused rapid progress for human civilization within the short two centuries. The advent of various new heat engines using fossil fuels has deepened humans' dependence on fossil energy.
> Electric energy is the secondary energy that is converted from other forms of energy. It is eventually transformed into light energy, internal energy, kinetic energy, and other forms of energy, and finally made available to humans. So, why use electric energy? It is because electric energy is easy to transmit and convert. Modern society cannot be separated from a variety of electrical appliances, turning electrical energy into various other forms energy converters. In the 1940s, a physicist invented a device that could control the energy released from nuclear reactions – a nuclear reactor- opening the prelude of nuclear energy as the representative of the third energy revolution. Over decades, nuclear power has become a relatively mature technology. Nuclear power is cleaner, more secure and more economical than coal-fired power, and nuclear energy has become conventional in many developed economies. (9th Grade Physics, p. 159-161)

In the last sub-section discussing energy issues in relation to the idea of sustainable development, the rapid growth of energy consumption is mentioned and the four conditions for future energy are outlined.

> All aspects of the life of humans – such as production, learning, and research – are inseparable from energy consumption. Due to a sharp increase in the world's population and continuous economic development, energy consumption is increasing.… If energy consumption grows such rapidly, wouldn't an "energy crisis" occur? Can humans solve this problem of the rapid growth of energy consumption?
> The impact of energy consumption on the environment: Humans' consumption of various energy sources will inevitably affect the environment.
> Mankind in the process of the energy revolution has achieved its own convenience, but also caused trouble. Currently oil and coal account for the vast majority of the energy sources, and annual consumption is growing. The burning of fossil fuels inevitably results in an increase in air pollution and the greenhouse effect. Some less developed countries are over-dependent on firewood energy, thereby increasing soil erosion and desertification. In short, human beings should not obtain from nature without restriction, and at the same time we must enhance the material progress and maintain the

harmony and balance of the natural environment.
The ideal energy source for the future: The ideal energy source for the future should be large enough to replace conventional energy sources such as soil, coal and natural gas. It must meet the following conditions: First, it must be abundant enough, ensuring long-term use; second, it must be cheap enough, guaranteeing that most people can afford; third, the technology must be mature, ensuring large-scale use; and fourth, it must be safe and clean enough, making sure that there is no serious impact on the environment. Students are the ideal future energy explorers and users. (9th Grade Physics, p 163-165)

To summarize, in China the energy-related contents are present in some parts of the grade nine chemistry textbook with regard to air pollution issues, as well as in some parts of the grade eight physics textbook in relation to electricity, but the most significant amount of energy-related information is present in the grade nine physics textbook where solar energy and nuclear energy are particularly emphasized.

② Japan

In the case of Japan, all of the five studied science textbooks for eighth graders have a section on electricity where electric energy is explained from a material perspective, while only textbook also briefly mentions environmental impacts. One of the textbooks adds a note at the start of the section, with a statement saying that more details on energy shall be dealt with in the third year of middle school:

Electric current can generate heat, light or sound, or move objects. The existence of any of these functions enables us to know that the object or material has an electric energy. The energy electricity has is called electric energy. Electric current-generated heat, light, sound, etc. are part of energy. Electric devices utilize electric energy. (Kyoiku Shuppan, p.89)

Light bulbs, fluorescent lamps, electric kettles, etc. generate light and heat as electric current flows inside them. Electric fans also operate on a motor powered by electric current. Electric current, therefore, can generate light or heat or move things. Such ability of electric current is called electric energy

(Keirinkan, p.187).

> Electric energy is gained by water/thermal/nuclear power generation, etc. If used in massive amount, electric energy caused huge loss of energy resources. At the same time, the heat or carbon dioxide, etc. coming from electricity generation impact the earth's environment. To protect our limited resources and the invaluable earth environment, we need to be considerate in using electric energy every day and put our consideration into practice. Electricity, compared with other kinds of energies, is a safe energy; it is easily controllable and transformable into light or heat. Thus, it is utilized broadly as a basic energy supporting people's daily lives and diverse devices for it have been developed in the area of welfare. Such properties of electricity need to be well utilized so that everyone can enjoy a convenient life. (Tokyo Shoseki, p.161)

> There are various kinds of energies, other than electricity, and they move something or generate heat. More details will be discussed in the 3rd-year. (Gakko Tosho, p. 83)

All five third-year middle school science textbooks of Japan dedicate large spaces to explain the details of energy-related education. Two of the textbooks contain, in their section on kinetic energy, the definition and explanation of the material properties of energy and some controversial issues related to resources. The other three textbooks, in addition to the section on kinetic energy, have a section on scientific technology and humans which deals with issues on energy preservation and energy resource utilization. The contents in all five textbooks, even though their classification and organization of the subjects differ, are not very different from each other. All the textbooks start with the definition of energy and move onto potential energy, kinetic energy, mechanical energy, and work and energy; then explain the principle of the conservation of energy and energy conversion.

The textbooks also present diverse kinds of energies in a sub-section, including elastic energy, electric energy, light energy, sound energy, heat energy, and chemical energy. This is followed by other subjects such as

energy change in everyday life and energy used in everyday, both of which explain that Japan gains electric power mostly by hydro, thermal, and nuclear power generation. Additionally a page or two are dedicated to describing the three power generational principles as well as their advantages and disadvantages. The next section on new energy resources mainly deals with solar power and wind power generation, leading to deeper consideration about a sustainable society with some controversies on energy resource use in the context of scientific technology development and natural environment changes:

> We have used, in our study, the world 'energy'. What is energy? … Energy means the ability to do work, and if an object is in a status of doing work, it is said to have energy. (Keirinkan, p. 154)

> The amount of energy can be marked as the amount of work done by or to an object. This is because the more energy an object has, the greater it can do work. The unit of energy is the same measure as the unit of work (symbol J). (Dainippon Tosho, p. 48)

> If such unusable energy generation decreases, we say 'energy efficiency is high'. Figure 10 shows the process to convert electric energy into light energy and there is a big difference in energy-use efficiency. (Gakko Tosho, p.61)

> Now, we have learned about dynamic energy, chemical energy and electric energy. Figure 2 shows that heat, light, and sound also have energy. They are each called heat energy, light energy and sound energy. (Tokyo Shoseki, p. 194)

> The sun has enormous amount of energy and its energy is mostly light energy radiated around and some of it reaches the earth. The light energy arriving the earth's surface is absorbed and becomes heat energy which circulates water in the air. And some of the sun's light energy is chemical energy used for plant photosynthesis. The chemical energy inside the fossil fuels we use every day such as oil is also from the sun's light energy. Fossil fuels are ancient creatures' bodies buried in the ground and changed for ages in the geological strata. The basis for them is the chemical energy gained by plant photosynthesis a long time ago. Using fossil fuels mean using the sun's light energy indirectly. As such most types of energy on earth are from the sun's light energy. (Kyoiku Shuppan, p.86-87)

> There are diverse energy resources in nature, including fossil fuels such as oil and coal and light energy. These are provided mainly in forms of chemical energy and electric energy to where we live. Electric energy, in particular, can be sent to many places via power lines and is easily

changeable into other types of energy such as light, heat or kinetic energy. Therefore, electric energy is one of the most easy-to-use energies. However, with the increasing electricity consumption each year, it is becoming important how to secure a stable electric energy supply. Here, we will think about how to use energy resources better by learning about electric energy that we can directly use.

Electric energy supplied for our basic daily living is sent by many power plants after estimating the demand in advance. As shown in Figure 1, thermal, nuclear and water power generation have large shares. But oil, coal or other fossil fuels for thermal generation and uranium for nuclear generation are limited underground resources and cannot be used for ever. So new energy sources as alternatives to fossil fuels are being developed and new and renewable energy use has been promoted. (Tokyo Shoseki, p. 202-204)

In the modern society, most frequently used resources for development are oil, coal, natural gas, uranium, etc. which will disappear if continuously used. So now is the time to use energy resources more efficiently and develop new kinds of energy that will not disappear even though used continuously. (Gakko Tosho, p. 67)

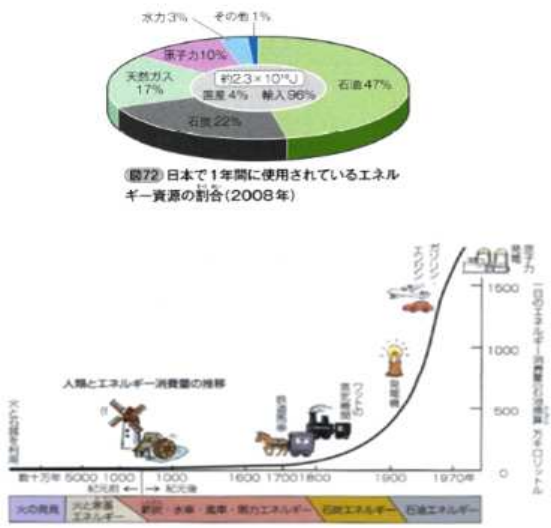
Scientific technologies play a great role in establishing a sustainable society. We should think about how better we can use scientific technologies to make efficient use of energy with only limited resources. (Dainippon Tosho, p. 278)

Scientific technology development has made our lives more convenient. This, however, has also required a lot of energy resources such as fossil fuels. A typical example is oil. … Since carbon dioxide causes greenhouse effect, increased carbon dioxide intensity in the air is regarded as elevating the earth's temperature. It is known that if global warming progresses, the sea level will rise and submerge low-lying areas and make them unlivable for people, as well as frequent floods and droughts will reduce crop production. Peoples' lifestyles relying on energy resources, such as fossil fuels, have adversely affected nature. As a counteraction, efforts have started to conserve the environment more with less impact on the nature. (Kyoiku Shuppan, p.219-220)

With a view towards the exhaustion of limited resources including fossil fuels, new power generation methods have been developed, such as sunlight, geothermal heat, force of wave and other natural energy power generation; dead leaves or other biological resources (biomass) generation, which can be used repeatedly; fuel cells that turns chemical energy into electricity, etc. For efficient use of energy resources, the cogeneration system and other diverse methods have been put into practice. Existing generation methods have also been improved with new technologies for improved energy-resource use efficiency. For instance, for thermal generation, a new technology has been developed for enhanced energy conversion efficiency; for nuclear generation, a nuclear fuel recycling technology (nuclear fuel cycle) has been developed which reprocesses nuclear fuel and reuses it for nuclear power generation. Carbon dioxide created by burning fossil fuels or wastes is a cause of global warming. The global community as a whole has tried to regulate carbon dioxide emissions. Burning biomass does not cause

carbon dioxide-level increase in the atmosphere because it is carbon dioxide that was originally in the air and was collected by plant through the process of photosynthesis. This property is called carbon neutrality. (Keirinkan, p. 176-176)

A remarkable feature of Japan's textbook is its detailed explanation on the country's power generation methods and principles explained together with various visual graphs and diagrams for the better understanding of students as shown in [Figure 2]. In other words, much of content focuses on delivering current domestic conditions of power generation and energy use, as well as energy issues in relation to sustainable development.



[Figure 2] Energy-related figures in Japanese science textbooks

③ South Korea

In the case of South Korea, all of the nine science textbooks for the

ninth grade have two units that contain energy-related contents. All of their unit 3 is on ‘work and energy’ where the meaning of work and energy is explained scientifically and the unit 5 is about electricity, containing scientific definitions of electric current, voltage and battery resistance, and explanations of electric energy, especially about safe and efficient electric energy use. Two of the nine textbooks stress the necessity of new energy resources in response to climate change in a unit on ‘atmospheric properties and weather change.’

Unit 3 of each textbook defines energy and elaborates on various types of energy such as potential energy, mechanical energy, and kinetic energy. The following are some examples of the definitions given on energy:

> Humans or animals can do work by eating foods and a subway train can move by turning a motor with electric energy supplied via power lines by a power plant. As such, we will look at what objects around us have the ability to work and what they need for work. The wind makes a ship sail, and electricity turns a fan. The ability to do work is energy. And there are many things around us, which have such energy. We are living by using their energy into work. (Kumsung Publishing Co., p. 147)

> To move an elevator, we need electricity and to move an automobile, we need fuel. The water falling from heights spins waterwheels, the wind spins pinwheels. Electricity, fuel, water, wind, etc. have the ability to work. And this ability to work is called energy. (Visang Education, p. 153)

> The ability to do work is called energy and an object in a status to work is said to have energy. The amount of energy is how much an object can do work. (Dubae Sense Book, p. 156)

> An automobile can run by burning fuel, humans can do work by eating foods. Therefore, fuels or foods can be said to have the ability to work. Such an ability to work is energy. (DH Book, p. 125)

To sum up, these textbooks scientifically define energy as the ability to do work and explain the kinds of energy as follows:

> Energy can be divided into various types such as mechanical energy, electric energy, chemical energy, heat energy, light energy, and nuclear energy. (Kyohak Publishing Co., p. 127)

> Energy exists in many different types - chemical energy, for instance, gained through chemical changes such as combustion or breathing, etc.; potential energy obtained by objects in high places; kinetic energy of a moving thing; heat energy varying according to temperature, etc. (Doosan Dong-A, p. 144)

> People use the energy stored in energy sources by converting it into forms necessary for daily lives such as light energy, sound energy, heat energy, and kinetic energy. As in Figure III -1, energy sources like coal or oil, store chemical energy and thermal power plants convert such chemical energy into electric energy. The electric energy sent to homes is changed to heat energy through an electric rice cooker, kinetic energy through a fan and light energy through a light bulb. (Chunjaemunhwa Co., p. 115)

> There are various kinds of energies in nature such as electric energy, chemical energy, light energy, etc. other than the potential energy, kinetic energy, and heat energy as we have learned now. When kinetic energy changes into heat energy, and when it is converted into other types of energies such as electric energy, the total amount of energy, including the whole amount of the converted energy, is kept the same. The universe is filled with energy. Energy can be changed into different forms but never be newly generated or destroyed. And the aggregate energy amount in the universe stays constant. This is called the principle of conservation of energy. (Dubae Sense Book, p. 163)

In the textbook excerpt above, the principle of energy conservation is explained along with diverse forms of energy. Frequently, parts like this also mention issues regarding energy resources and the environment. More details can be seen in the excerpt below:

> According the principle of the conservation of energy, it is impossible to make an engine permanently working without energy supply. In order for a machine to work, it needs energy supply. And although it works initially with the energy supplied, it finally stops, creating heat energy due to friction or air resistance. If the entire forms of energies are taken into consideration, energy is conserved but it is conserved in form of heat energy or other forms, which are hard to convert again for appropriate use. This explains why we should conserve energy. (Chunjae Education Inc., p. 176)

> Energy is conserved no matter in which forms energy is converted into, then why we should save energy? In case of the automobile explained before, it consumes fuels and generates heat energy that changes into diverse energy forms such as kinetic energy, electric energy, sound energy and light energy. But after all work, these all enter the air as heat energy. We can easily gain energy from fuel resources including coal or oil whenever necessary. If it is as easy to gain energy from the heat in the air or sea, we may not need to save energy. But such heat energy in the air

> or sea is not easily usable. So we should utilize energy resources efficiently and save them. (Kyohak Publishing Co., p. 157)

The unit 5, on the other hand, seeks for a scientific understanding of electricity, thus emphasizing electric energy only. The section on electric energy mainly stresses safe, reasonable, and efficient use of electric energy. Also, the textbooks commonly state about South Korea's labeling systems on energy efficiency:

> Since electric energy is generated mostly by using other forms of energy, it costs a lot, thereby increasing the need for its efficient use. Also if energy is converted into electricity, it becomes hard to store. … Generating electricity not for immediate use means a waste of energy. So we should try to save electric energy. Additionally, in case of using the same kind of electric appliances, using the one with higher energy efficiency will reduce waste of electric energy. South Korea has a operated labeling system on energy efficiency and the system is helpful for people to choose products having higher energy efficiency. (Kumsung Publishing Co., p. 252)

> If we save more electric energy and efficiently use it, we can not only conserve our resources but also reduce carbon dioxide emissions from electric energy generation processes, thereby mitigating the impacts from global warming. So it is desirable to turn off any unnecessary lights, increase air conditioner temperatures, and change fluorescent lamps to energy-efficient LED bulbs for less energy consumption. South Korea, for efficient energy use, has made an energy-saving mark to be attached to energy-efficient products and every electric product shows its ranking of energy efficiency. (Doosan Dong-A, p. 272)

> Most electric appliances have a label of energy efficiency from 1~5 grades according to their energy use effectiveness or energy usage amount. 1st-grade products can save up to 30~40% of energy as compared to 5th-grade products. Using more 1st grade appliances will be greatly helpful for nationwide energy saving and greenhouse gas reduction. Home appliances such as computers, televisions, etc. use a considerable amount of standby power even when they are not in operation. Copying machines or VCRs are estimated to use almost 80% of the actually used energy. Such wasted standby power accounts for over 10% of the entire South Korean electric energy consumption. Therefore, it is desirable to use products that consume lower electricity on standby mode and unplug electric appliances when not using them. Generally one air conditioner uses the same amount of energy used by 30 electric fans; we should try to use fans more and not air conditioners especially from 2~4 p.m. in the summer season when electricity use jumps. We can also find more electricity-saving ways around us. If we put them into practice every day, we will save more electric energy. And by doing so, we can lower greenhouse gas emissions and pass on a clean earth to future generations. (Mirae 'N Co., p. 252)

> Most part of the energy we use at home or school is in form of electric

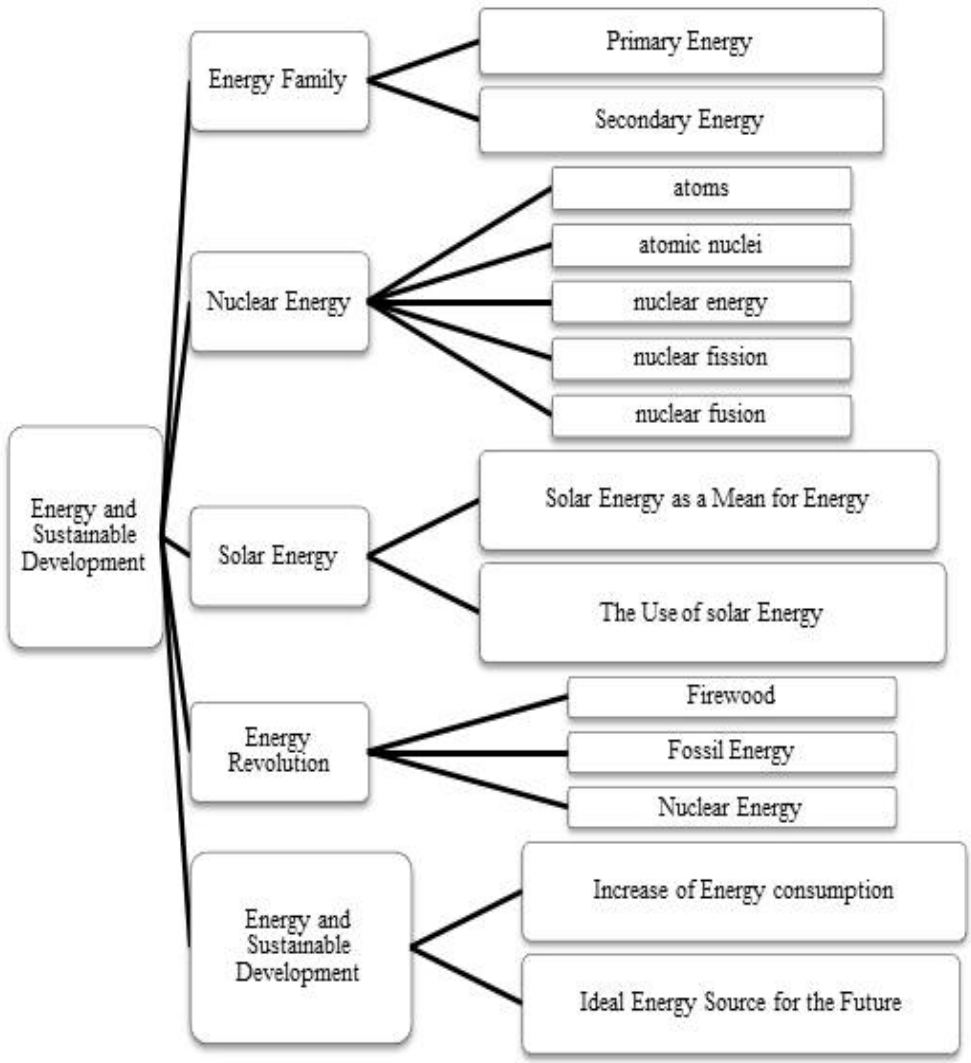
> energy. Therefore, saving electricity can help resolve the earth's energy problems and prevent environmental destruction caused by excessive energy use. To this end, we can practice to shorten the time for using electric appliances, use energy-efficient products and unplug electric devices not frequently used in order to save unnoticed energy leakage and conserve our environment. (Chunjaemunhwa Co., p. 245)

As mentioned before, in addition to the units 3 and 5, the two textbooks dealing with energy have unit 4 which presents atmospheric properties and weather change. The excerpts from this section show how climate change and energy-use issues are explained:

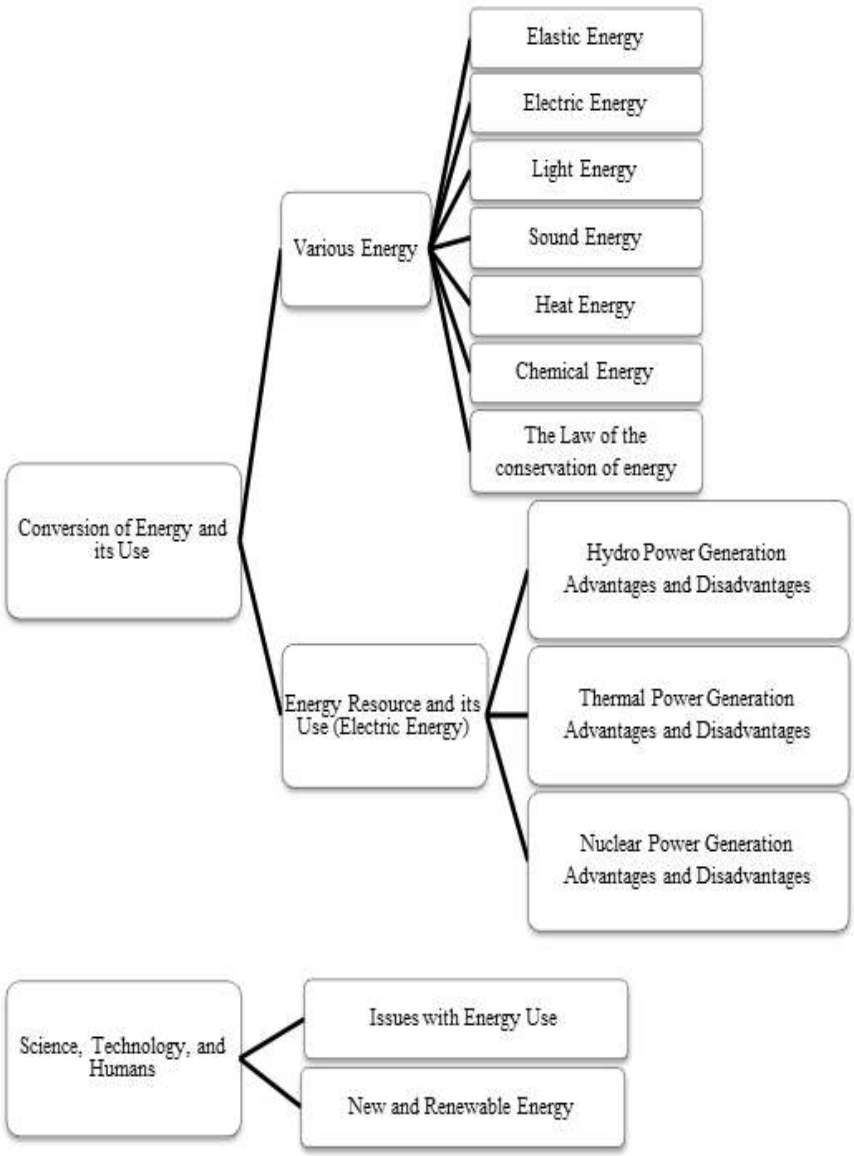
> Due to global warming the earth's temperature has been rising and this is accompanied by more frequent destructive weather events. To adequately respond to this situation, the global community adopted the Climatic Change Convention in 1992. The convention is a commitment of the human race to gather its full strength to prevent the earth's climate change. To implement the convention, each state consults and acts upon how much greenhouse gas emission it would reduce. To address the climate change problem fundamentally, the current energy-using system based on fossil fuels should change. Instead of fossil fuels, we should construct facilities for sunlight or wind power generation, etc. and develop technologies to decrease carbon emissions even though fossil fuels are still used. (Chunjaemunhwa Co., p. 203)

> (206) Warnings keep arising against climate change. The most likely reason for climate change is the global warming caused by fossil fuel consumption. Since human civilization relies heavily on fossil fuel consumption such as oil and coal, its fundamental energy consumption structure should change. Recognizing this, scientists have worked to find new energy resources that have little impact to the environment. (217) Carbon dioxide emission has a direct relationship with the amount of energy used and with economic growth. The issue, in this sense, sometimes creates conflicts between states. So, for a sustained economic growth, a state should restructure its society with less carbon dioxide emission. (Dubae Sense Book, p. 206 & 217)

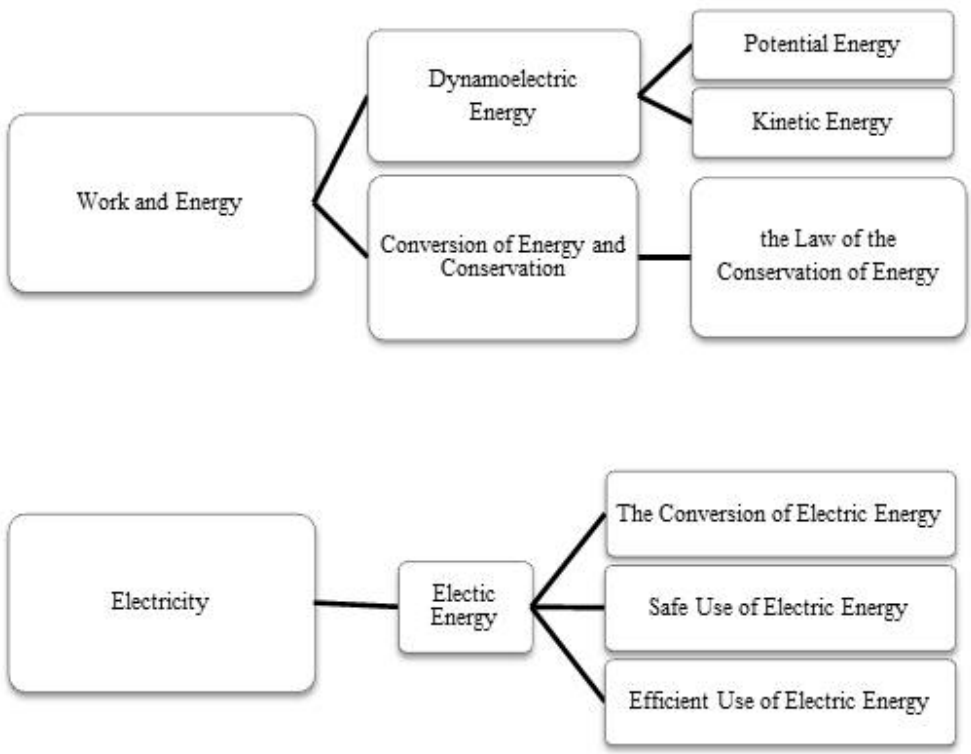
Unlike Chinese and Japanese textbooks, South Korean textbooks tend to limit their energy-related contents to the discussion of scientific approaches and do not give as much attention to issues of sustainability.
The figures (3, 4 and 5) in the next three pages summarize the organizations of major energy-related contents in each country's science textbooks.



[Figure 3] Organization of energy-related contents in Chinese science textbooks



[Figure 4] Organization of energy-related contents in Japanese science textbooks



[Figure 5] Organization of energy-related contents in South Korean science textbooks

3) Analysis of Social Studies Textbooks

Energy-related contents in social studies textbooks are approached from different perspectives when compared to the energy-related contents in science textbooks. The analysis of social studies textbooks is organized in the same flow as the preceding analysis of science textbooks. Interestingly,

grade nine textbooks are mostly the ones with energy-related contents, which is in accordance with the analysis of science textbooks. [Table 12] shows the social studies subjects that contain energy-related contents.

[Table 12] Social studies subjects with energy-related contents

	Subjects with Energy-related Contents
China[14]	Geography (grade 8), History and Society (grade 9)
Japan	Geography, Civics (No grade division)
South Korea	Social Studies (grade 9)

① China

As mentioned in the data collection and curriculum analysis part, subjects that belong to social studies in China such as history, history and society, geography, and thoughts and morality do not give a good deal of space to the discussion of energy issues especially when compared to South Korean and Japanese social studies textbooks. In fact, in the search for the word “energy” in Chinese textbooks, none was found. Nevertheless, resource issues are dealt in both history and society and geography textbooks together with the issue of the country’s increasing population. It is possible that the concept of energy in China is more likely to be treated in a scientific context rather than in a social context. In the middle school grade eight geography textbook and grade nine middle school history and society textbook, ‘natural resources’ and ‘increasing population’ are the main key words that most frequently appear in the resource-related units. Also, the grade nine history and society textbook has a unit on sustainable development which emphasizes the issue of increasing population with

14) In the case of China, this refers to resource-related contents as none of the social studies textbooks contain energy-related contents.

respect to the sustainability of Chinese society. Although the aim of the present work is to compare and analyze energy-related contents, resource-related contents of Chinese social studies textbooks are briefly discussed here so as to compare the context in which relevant knowledge is discussed among three nations. The excerpt below from the history and society textbook shows how it relates the resource issues with humans' life, and [Table 13] summarizes the subjects and headings that have resource-related contents.

> The production (of a material object or good) and the life of humans cannot be separated from various natural resources of the natural world. Such natural resources with use value are land, sunlight, minerals, forest, and water, etc. (60)

[Table 13] Chapter headings containing resource-related contents in Chinese social studies subjects

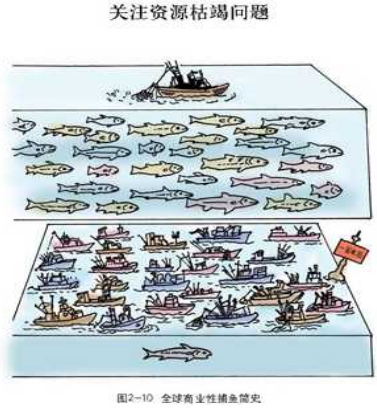
Subject (year)	Headings
Geography (Grade 8, Vol 1)	Unit 3. Natural Resources in China Part 1. Total amount of natural resources is abundant but short per capita Part 2. Land resources Part 3. Water resources
History and Society (Grade 9)	Unit 2. Establishing a Sustainable Society Part 1. Mankind has only one Earth Part 2. Confronting China's population, resources, and environmental issues Part 3. Sustainable Development – Our Choice

Again, China's social studies textbooks do not address energy issues in depth, yet address resource issues in conjunction with that of population growth by emphasizing the finiteness of resources. For example, the history and society textbook states that population, resource, environment, and development are a so-called 'PRED' problem and further discusses the related issues in its unit 2. Also, the title of the sub-section in the history

society textbook is “A Country with Boundless Natural Resources or a Country with Limited Natural Resources?” In this unit, the text mainly addresses the issues related to oil (petroleum). In particular, the reading material in one geography textbook addresses the fact that China has shifted from being a net oil exporter to a net oil importer. [Figure 6] is a figure in the textbook that shows the distribution of petroleum in China.

[Figure 6] A Figure showing China’s petroleum distribution in a Chinese social studies textbook (History and Society, grade 9)

Also, some figures in the textbook, as the figure shown below, illustrate how the finiteness of resources is being emphasized, which again shows the tension between the limited natural resources and population growth.



[Figure 7] A Figure showing finiteness of resource issues in a Chinese social studies textbook (History and Society, grade 9)

② Japan

All four Japanese geography textbooks and seven civics textbooks present energy-related contents, and most textbooks contain energy as a subtopic.

The four geography textbooks provide general information about the world's energy resources first, and then address Japan's resources and energy-related contents in conjunction with the environmental issues in Japan.

> When looking at mineral resource producing areas in the world, coal reserves are distributed all over the world, whereas oil reserves are concentrated in the Caspian Sea region in Persia and the Caribbean coastal regions. Furthermore the distributions of uranium, tin, and bauxite are more unequal.
> Until now, energy has been most consumed in the developed countries such as Japan or the United States. Nowadays, the world's energy consumption continues to increase due to population growth in the developing countries, industrialization, and the dissemination of automotive and electronic products. In particular, the increasing greenhouse gases such as carbon dioxide emitted into the atmosphere due to the massive use of fossil fuels have become global issues. Due to this, diversified efforts, such as using new renewable energy like solar power and wind power, are being made to reduce the carbon dioxide emissions as a solution to mitigate global warming. Furthermore, mineral reserves are limited. The

whole world seeks to use the limited mineral resources more effectively to accomplish a sustainable society. Meanwhile, many efforts are being made to use biologically engineered ethanol from corn as an energy source, yet there are voices opposing the use of agricultural products as an energy source.
Attempts to use new renewable energy through reducing the financial aid on limited minerals and taxing the environmental pollution are being made all over Japan. For example, solar power generation is being introduced to houses, office buildings and public facilities such as schools because it has relatively less limitations when it comes to space for the installation. (Tokyo Shoseki, p. 144-147)

World's energy consumption: The developed countries, including Japan, use hundreds of times more energy than the developing countries to maintain the advanced industries and high standard of living. Furthermore some developing countries with established industries are increasingly consuming more energy.
The energy source of each country varies depending on the resource produced in that country and the policies of that country. The U.S. uses relatively much natural gas as well as petroleum. In France, nuclear power generation accounts for 40% of the total power generation.
Energy consumption and renewable energy in Japan: Japan is one of world largest energy consumers, and petroleum accounts for the biggest proportion of the total energy consumption. However, oil reserves are limited. Furthermore, petroleum generates massive amount of CO_2 when burned, which leads to atmospheric and land pollution. Thus, a variety of efforts to use wind power, geothermal power, and wind power are needed, and their development is in progress. However, there are a number of challenges in the development and use of new renewable energy such as technical issues and high cost of power generation. Currently, the power generated by renewable energy accounts for only 1% of gross power generation. The efforts to overcome this challenge continue. (Nihon Bunkyou Shuppan, p. 171-172)

Electric power, is produced by thermal power, hydropower, and nuclear power, etc. Many countries rely on hydropower generation, yet some countries rely on nuclear power or thermal power generation. Japan, mainly relies on thermal power generation using oil, coals and natural gas, and is increasing nuclear power generation due to the increase in power consumption. Due to low self-sufficiency rate, Japan is at the stage of developing energy based on natural forces such as wind or solar energy. These types of energy have less effect on the environment, yet some challenges remain such as the fact that power generation capacity is limited. (Teikoku-Shoin, p.147)

All seven of Japan's civics textbooks also address energy-related issues. One section on the 'international community' directly addresses resources and energy issues. While geography textbooks mainly deal with the introduction of energy resources and the distribution of world energy sources, the civics textbooks provide the outlines of global energy issues,

sustainability of the earth, and the future of mankind, and contemplate on them. Terms such as ‘sustainable society’ and ‘new renewable energy’ are used often in the textbooks.

> Currently global human population has reached approximately seven billion. The population of Japan or European countries is stable, yet world population continues to increase, mainly in developing countries. The world population is expected to reach approximately 8 to 9 billion in the year 2050. The growth of the population at this pace will lead to food and energy shortages, resulting from the need to increase agricultural and industrial production. (Nihon Bunkyou Shuppan, p.200)

> In modern times with developed industries, a large amount of resources and energy are used to produce a large quantity of products, resulting in a large amount of waste. Thus, the negligence of waste treatment will impede the ability of nature to assimilate waste and regenerate resources.. (Kyoiku Shuppan, p.168)

> As the demand for safe and sustainable energy increases, many countries are developing new renewable energy utilizing solar power, wind power, wave power, hydroelectric power, geothermal energy and biomass (biological resources). Despite the challenges regarding development cost and stable supply, Japan seeks to expand the use of renewable energy and reduce the production cost. (Kyoiku Shuppan, p.185)

> Energy Consumption: Regarding the energy consumption in Japan, the industrial sector accounts for more than half of energy consumption, yet the consumption level is stable since the 1970s. On the other hand, household energy consumption continues to increase, reaching three times the energy consumption of the early 1970s. The distribution of consumer electronics such as refrigerators, air conditioners, microwave ovens, and so on contributes to this increase. Meanwhile, Japan imports 96% of its energy sources. Since the oil crisis in the 1970s, the oil price rose and it became difficult to secure stable supply of energy source. Thus, Japan has introduced nuclear power and natural gas, in an effort to diversify the energy sources. (Tokyo Shoseki, p. 166)

From the excerpt above, it is assumed that Japan which has industrialized earlier than other Asian countries has directly experienced the seriousness of energy supply problems from the “Oil Shock” in the 1970s and has made efforts at the national level since then. Furthermore, the textbooks also describe the energy issues from the global perspective, indicating that Japan has pondered upon energy issues for a long time.

More excerpts from different publishers are as follows:

> Securing Energy and Resource Saving: As we experienced from Oil Shock in 1973, if oil import stops due to some reasons, the industry and the life of a nation which has no domestic energy sources will be greatly affected. Based on this lesson, Japan has embarked on the development of energy saving technology at the national level and has accomplished the world top energy saving technologies. However the energy consumption continues to grow in the private sector and more energy saving effort is needed. In this regard, Japan also has made great efforts to expand nuclear power generation and new renewable energy. However the accident in the nuclear power plants in Japan due to the Great Eastern Japan Earthquake in 2011 has again brought about serious energy issues. Thus, the dissemination of natural energy generation using solar power and wind power, and the utilization of the methane hydrate discovered under the seawaters are most urgently needed. (Jiyuusha, p. 173)

> Creating our future starts with looking at our daily life. Our life is built on the wisdom and efforts of our predecessors. On the other hand, we, excessively consume energy in the pursuit of a convenient and abundant life, which results in the destruction of the natural environment. Furthermore some people in the world are suffering from more severe food shortage and poverty, whereas some people are enjoying an affluent life. (Shimizushoin, p. 178)

③ South Korea

In South Korea, all eleven of the grade nine social studies textbooks address ‘development of resources and use’ in unit 1 and ‘different environmental issues depending on region’ in unit 3. Unit 1 introduces resources, the limited oil reserves, and the issues arising from the increase in resource consumption, particularly regional conflicts. Some textbooks also address the effective use of natural resources:

> Resources can be divided into several kinds. Resources can be largely divided into natural resources such as energy resources, food resources and forest resources, and human and cultural resources such as labor, systems and technology. And the natural resources can be divided into renewable resources such as solar power, tidal power and wind power and non-renewable resources such as petroleum and natural gas. (Daekyobook, p. 14)

> Since the advent of the industrial revolution, the global demand of energy

and mineral resources has been apace with increasing global industrialization. This is particularly so with regard to the demand of the resources needed in the industrial sector such as petroleum, iron ore and copper increases due to the improvement of living standard and those resources are widely traded all over the world.
Coal, which served as the driving force of the industrial revolution in the eighteenth century, is mainly buried in old orogenic folding mountains; and the US, China and India are the major producers of coal. As petroleum is become widely used, the usage of coal has decreased, yet coal is widely traded all over the world because it is still used in the steel industries.
Oil is the most widely used energy resource and is used as the raw material in chemical industries. Buried in cenozoic folding mountains, oil is mainly produced in the Persian Gulf; is limited to certain regions only; and is globally traded. Oil producers established the Organization of Petroleum Exporting Countries to exercise their influence on the global oil market, by controlling the largest oil sources globally.
In most cases oil and natural gas are buried together. Due to the development of improved storage and transportation technologies, the production and consumption of natural gas is rapidly increasing. Russia and the US are the main producers. (Kyohak Publishing Co., p. 85)

Korea's energy consumption ranks number 10 in the world. With respect to energy, Korea mostly relies on import and the amount of energy import reaches 25% of the country's total import. Securing a stable energy supply is closely associated with the economy. Korea, the world's 7th largest oil consumer, is very vulnerable to an energy crisis, and particularly has a high dependence on oil import. 80% of oil is imported from Southwest Asia and 40% of the natural gas is imported from Southeast Asia.
The best way to use the limited resources for a longer period of time is to save them and use them more efficiently. By increasing energy efficiency, a great proportion of energy consumption can be reduced. The technology to make light bulbs, home appliances and automobiles continues to develop in the direction of improving energy efficiency. Due to the distribution of LED bulbs with a near-permanent life span and excellent brightness, yet having low energy consumption, incandescent lamps are likely to soon disappear. With respect to automobiles, hybrid cars, which use both electricity and fuel, are being commercialized. Many companies are making efforts to produce energy-efficient products, and the government supports these companies actively. Thus, consumers can save energy by comparing the energy efficiency of products before making a choice. (Kumsung Publishing Co., p. 30-31)

Intense competition among countries, between and through regional alliances, for the sake of securing energy supplies, is causing global political and economic conflicts. Latin American countries with rich energy resources, such as Venezuela and Bolivia, plan to control the production cost of regional oil and natural gas. Russia has increased the price of natural gas to the former Soviet countries more than twice, thus using resources as economic weapons. The cases of the gas crises between Russia and Ukraine in 2006 and 2009 are perfect examples. Furthermore the competition to secure the natural resources in the Arctic Ocean is resulting in international conflicts in conjunction with the issue of territorial sovereignty between neighboring countries. (The Text Publishing, p. 24)

> Since the industrial revolution, industrialization has spreads to many parts of the world and as a result the energy consumption is steadily increasingly. This trend is more obvious in the case of developing countries with a rapid rate of industrialization. As a result, despite having a smaller energy consumption per capita than that of the developed countries, the total energy consumption of the developing countries is rapidly increasing.
> The expansion of energy production is mostly concentrated on fossil fuels, such as coal, oil and natural gas. However, the fossil fuels will be depleted someday because they are not recyclable, and are buried in certain regions only, resulting in the mismatch between global supply and demand. (Jihaksa, p. 24)

Unit 3 mostly addresses the introduction of 'environmentally friendly development' and 'a need of the development of new renewable energy and the types of new renewable energy' from the perspective of the handling of environmental problems, whereas unit 1 mostly addresses the conflicts due to energy resources in conjunction with industrialization and population growth. One of the distinctive features of South Korean social studies textbooks is the discussion of green growth policy in dealing with energy crisis, which can be interpreted as the efforts made at the governmental level:

> Green growth: The world is in the midst of crises due to the natural disasters arising from climate change and the destruction of the environment arising from an increase in energy consumption. However, mankind continues to make efforts to live in harmony with the nature. Mankind needs to overcome the energy crisis and global warming and accomplish green growth through sustainable growth, considering both economic growth and environmental protection.
> Green growth: Green growth means the harmonized growth between economy and environment on the basis of energy independence and the creation of a new growth engine and new jobs. (Kyohak Publishing Co., P. 82)

> For environmentally friendly development, (it is necessary to have) the mindset to save the limited energy resources and (to take) efforts to use recyclable energy. Furthermore there is a need to introduce development methods to minimize environmental impacts and reform the industrial structure; to develop renewable, new and environmentally friendly energies; and to use energy efficiently.
> The development of new renewable and environmentally friendly energy must be in accordance with regional characteristics so as to develop regional potential and minimize environmental pollution. In particular, the development of new renewable energy by using the rich natural resources such as solar energy, wind energy, geothermal energy, water and

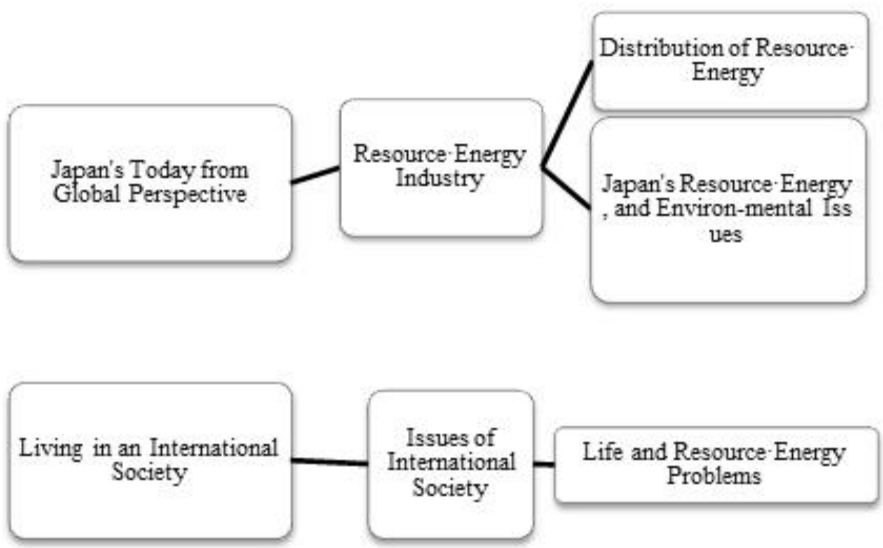
bio-energy in the corresponding regions is essential to sustainable development. (Kyohakongusa, p. 83).

New renewable energy is closely associated with the geographical environment of each area. The area with rich insolation is ideal for the development of solar energy; and high mountains and coastal areas with good wind are ideal for the development of wind energy. Hydropower generation by using melted snow and glacier water is ideal in alpine regions and volcanic areas use geothermal energy to generate power. The areas with great sea level changes like the west coast of Korea can generate tidal energy. Furthermore the thermal energy obtained from burning waste can be used for heating and generating electric power; and through the decomposition of plants, such as corn or sugarcane and animal manure, bio-energy can be produced. Renewable energy accounted for 0.5% of the world energy use in 2010. However, a variety of technologies utilizing new renewable energy are under development and the outlook is very bright. Korea mostly relies on energy import and needs to pay more attention to the development of new and renewable energy. (Kumsung Publishing Co., p. 82)

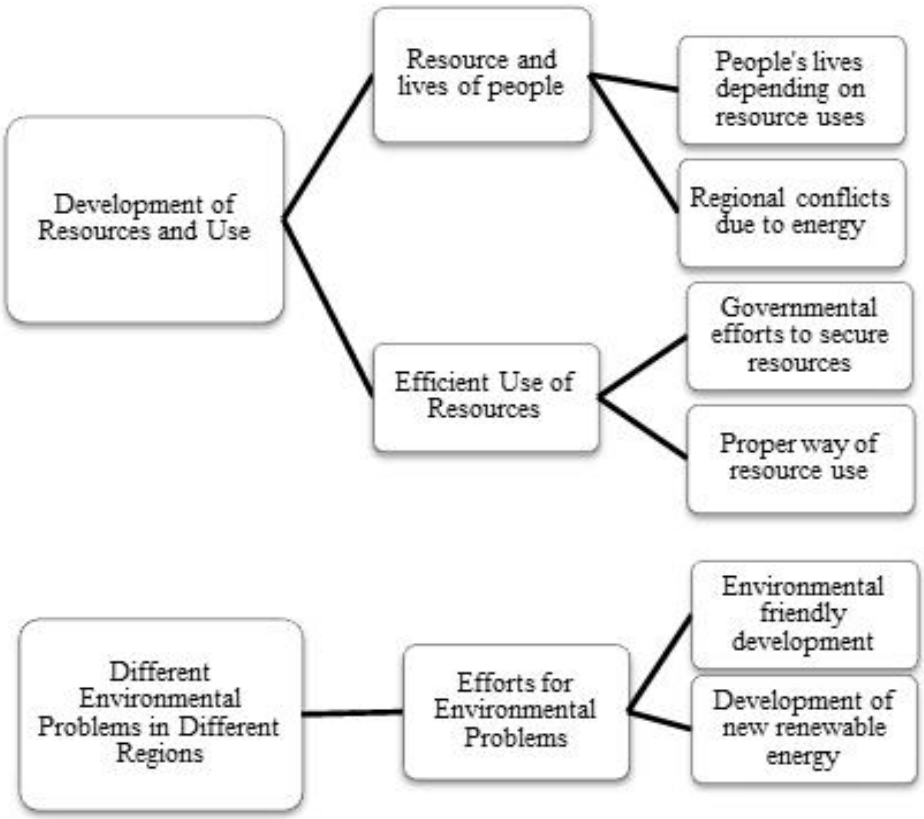
Advanced countries including Europe and Korea pursue Low Carbon Green Growth Policy, aimed at sustainable growth. Korea also focuses on green industries that use resources efficiently and minimize environmental pollution, and green technology which will be the growth engine in the future.
We need to make individual efforts to use low carbon environmentally friendly goods in our daily life and to use public transportation or ride bikes or take a walk. Furthermore schools and households need to regularize recycling garbage and make efforts to minimize the wasted energy. (The Text Publishing, p. 75)
The energy that mankind mostly relies on is fossil fuels such as petroleum, coal, and natural gas. Fossil fuels will be depleted someday and moreover produce pollutants during their development and use. The energy that can overcome these problems of fossil fuels is new renewable energy. Thus, the importance and need for the development of new renewable energy increase because the new renewable energy can be the solution to environmental problems and the depletion of fossil fuels. New renewable energy includes renewable energies such as solar energy, biomass, wind power, hydro energy, marine, waste and geothermal energy and new energy includes technologies such as fuel cell and hydrogen energy. This new renewable energy has less effect on environment due to low discharge of pollutants, yet there are some challenges to overcome, such as cost-effectiveness and stable supply. Recently, Korea is seeking to develop new renewable energy, by pursuing ‘Low Carbon Green Growth.’ (Jihaksa, p. 76)

In conclusion, it is found that energy-related contents are dealt with resource issues in social studies textbooks as well as with the idea of sustainable development. China clearly shows its interest in approaching

population and resource problems. While Japanese textbooks put emphasis on world energy consumption as well as domestic energy consumption issues, South Korean textbooks tend to pay special attention to regional conflicts arising from energy security and to the nation's green growth policy. More implications and significance of the findings will be discussed in the discussion section. The two figures below (Figure 8 and 9) summarize the organization of energy-related contents in Japanese and South Korean social studies textbooks.



[Figure 8] Organization of energy-related contents in Japanese social studies textbooks



[Figure 9] Organization of energy-related contents in Korean social studies textbooks

3. Comparison of Nuclear Energy Education[15)]

In the examination process, nuclear energy-related contents show the most distinctive differences and characteristics among nations in terms of knowledge selection and description. Among the total of 111 textbooks (23 from China, 26 from Japan, and 62 from Korea), 34 are selected with contents pertaining to nuclear power or nuclear energy. Usually the textbooks with energy-related contents are also the ones with nuclear energy-related materials, but in the case of Korea textbooks that contain energy-related information mention only little or no nuclear energy-related information. Therefore, the total number of textbooks with energy-related contents and that of textbooks with nuclear energy-related content are different. [Table 14] below summarizes the subjects that contain the pertinent material.

[Table 14] Subjects with nuclear energy-related contents

	Social Studies	Science
China	None	Chemistry (grade 8), Physics (grade 8 and grade 9)
Japan	Geography Civics	Science (grade 9)
South Korea	Social Studies (grade 9)	Science (grade 9)

1) Analysis of Science Textbooks

15) Much of this section have been presented in Kim, GoWoon, & Yun, Sun-Jin (2012). *A comparative study of nuclear power education in China, Japan, and South Korea: based on the concept of technological citizenship*. Paper presented at the The 10th East Asian STS Conference, Seoul National University, Korea.

In accordance with the analysis of energy-related contents in general, the contents related to nuclear power are mostly covered in the ninth grade textbooks, but the contents are categorized into different themes as shown in [Table15] below.

[Table 15] Comparison of headings of the nuclear energy-related sections in science textbooks

	Subject	Headings (Publisher)
China	Chemistry (grade 9)	• Environmental Impacts of the Use of Fuel (People's Education Press)
	Physics (grade 8,Vol.2)	• Electric Energy (People's Education Press)
	Physics (grade 9)	• Energy Family • Nuclear Energy • Energy Revolution • STS Nuclear Power Plant and Nuclear Waste Disposal (People's Education Press)
Japan	Science (grade 9)	• Various Energies and Conversion (Keirinkan) • Energy·Resources and their Uses (Keirinkan) • The Conversion of Energy and the Uses (Gakko Tosho) • Energy Resources and their Uses (Kyoiku Shuppan) • Work and Energy (Dainippon Tosho) • Important Energy Resources (Dainippon Tosho) • Various Energies, Scientific Technology and Humans (Tokyo Shoseki)
Korea	Science (grade 9)	• Voltage and Electrical Resistance (Kyohak) • How Can Energy be Converted and Conserved? Work and Energy (Chunjae) • The Conversion and Conservation of Energy, Work and Energy (Visang) • The Conversion and Conservation of Mechanical Energy, Work and Energy (Dubaebook) • The Use of Electric Energy, Electricity (Mirae-n) • Using Electricity Safely and Efficiently/ Electricity (Doosandonga)

In China, in the unit "Fuel and the use of Fuel" in the ninth-grade chemistry textbook, nuclear energy is mentioned. The book reads, "Currently,

humans are using and developing new alternative forms of energy, such as solar energy, nuclear energy, wind energy, and geothermal energy." Also, in the second volume of the eighth-grade physics textbook, the description of a power plant image in the section titled "Electric Power" reads, "The total generated amount of fire/water/nuclear power generation in China exceeded 13,556 kWh,[16] ranking second in the world."

While these two textbooks only mention nuclear energy, the ninth-grade physics textbook introduces nuclear energy on a considerable scale in its unit "Energy and Sustainable Development" as mentioned earlier. In the beginning of the sub-section titled 'energy family' it is explained that nuclear energy is a primary energy directly derived from nature and that it belongs in the non-renewable category, which contradicts how it is explained in the chemistry textbook. Basic explanations of atoms, atomic nuclei, nuclear energy, nuclear fission, and nuclear fusion follow in the sub-section titled 'nuclear energy', and the unit is concluded by hoping that the students contribute to the solution to energy resource issues that face mankind by further developing nuclear fusion reactors for nuclear energy use in the future, as described below:

> The proton and the neutron are closely woven with strong energy bonds. Therefore the atomic nucleus is so solid that it is difficult to separate or integrate again. However, once nuclear fission or the polymerization is achieved, tremendous energy is emitted. The energy is called as nuclear energy. … (Physics Grade 9, p. 151)

> The nuclear power plant uses nuclear energy to generate electricity, and its core facilities are nuclear reactors. The chain reaction occurring in a nuclear reactor can be controlled. … (Physics Grade 9, p.152)

16) The chemistry book was published in 2006, so it is likely that it will have the 2005 figures. In 2005, total annual electric power generation in China was close to 2370 TWh. In 2006 it was 2717 TWh. It was indeed second highest in the world. See:http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=2&pid=2&aid=12&cid=regions,&syid=2001&eyid=2010&unit=BKWH

> If the chain reaction isn't controlled, enormous atomic nuclei fissions can occur, leading to the generation of the maximum amount of energy. This chain reaction resulting in an atomic explosion is not uncontrollable…
> Scientists expect that controllable nuclear fusion reaction can generate tremendous nuclear energy, which shall be enough to solve mankind's energy problem thoroughly. Hope you students will contribute to such work in the future. (Physics Grade 9, p.152)

> A physicist in 1940s invented a device to control the nuclear energy's release. The device is the nuclear reactor which was a great invention allowing nuclear energy to be the prologue to the 3rd Energy Revolution. Several decades since the invention, nuclear power generation has become a substantially developed technology. As nuclear energy generation is cleaner, safer and more economical, it has become a general source of energy in industrialized nations. (Physics Grade 9, p. 160-161)

In the Chinese science textbooks, there are contents that approach these scientific issues from the science, technology and society (STS) perspective under the theme of 'STS', but the contents seem to be not so related to the STS concept. For instance, much of the STS context related to nuclear power focuses on the issues of nuclear power plants and nuclear waste disposal processing. The passage below is a direct translation of the context:

> A nuclear reactor is the facility to control the nuclear fission reaction. When the uranium fission is achieved in the nuclear reactor, enormous energy is generated, and radiation can be produced. If the radiation is released to the outside of the nuclear reactor, almost all types of creatures including human being can be harmed from the radiation. Therefore a nuclear reactor is sealed in ferroconcretes. …
> Ferroconcretes are used for isolating nuclear reactors, but further strict safety measures and regulations are being established due to several nuclear leakage accidents. Generally, accidents do not occur unless there is an external attack. …
> Developed countries are landfilling their nuclear wastes in neighboring countries. Nuclear energy is the only choice for mankind that can solve the issue of the current energy crisis. (Physics Grade 9, p. 153)

The five Japanese ninth grade science textbooks assessed here include technical information regarding nuclear power generation in the units on "Exercise and Energy" or "Energy Sources and their Uses." The content mainly offers explanations of the processes of how energy is derived using

nuclear fission technology. These units also mention that in some cases, a large amount of energy can be produced with a small amount of nuclear fuel, with the advantages of not producing any carbon dioxide as well as the disadvantages coming from the issues related to radioactive and nuclear waste:

> The energy harnessed from the atom's nuclear reaction (nuclear fission, etc.) is called as nuclear energy. The nuclear energy generation boils water to produce tremendous steam. The hot steam turns turbines in the nuclear power generator. (Keirinkan, p. 163)
> The thermal power generation and the nuclear power generation is similar in that the both types turn much water to tremendous, high-temperature and high-pressure steam, which turn the power generators, but they are different in that the thermal power generation uses the thermal energy produced at burning petroleum, coal or natural gas whereas the nuclear power generation uses the nuclear energy created from the nuclear fission. (Keirinkan, p.172)

> However, the amount of uranium as an underground resource is limited. And the radiation generated in an atomic reactor is very harmful to cells or genes of a creature, so it needs to be extremely carefully managed. Besides there are other problems to be solved including the nuclear waste emitting some radiation over a long time. (Gakko Tosho, p.64)

> The way to generate electricity using the thermal energy gotten by the nuclear fission is called as the nuclear power generation. In this process nuclear fuel undergoes nuclear fission in an atomic reactor to produce high-temperature, high-pressure steam. And the steam turns turbines in an electricity generator. Atomic power generation has the advantages of producing enormous energy from small-amount nuclear fuel as well as no exhaust gas to pollute the air. But the nuclear waste generated from nuclear fuel or nuclear power generation is extremely harmful to all creatures, and requires very sophisticated technology for controlling the atomic energy generated from the nuclear fuel (Kyoiku Shuppan, p. 90).

In three of the Japanese textbooks, there is content related to nuclear power generation and radiation, with an explanation that the prolonged and strong exposure to radiation can harm the body physically:

> Use of Nuclear Power and Challenges: As the nuclear power generation creates tremendous energy from a small amount of nuclear fuel and generates almost no carbon dioxide when generating electricity, one-third of electric energy generated in Japan is produced from nuclear power plants. Meanwhile, substantial radiation generated by the nuclear fission is gathered in a nuclear reactor, and when some radiation is leaked to outside, it can pollute the soil, the water, the farming crops, and the marine products as well as seriously harm people's health. Additionally, because the used

nuclear fuel includes some radioactive materials continually emitting radiation, so a nuclear power generator should be managed safely. Also, we need to be extremely careful in using nuclear power. (Dainippon Tosho, p. 272)

Radiation's Attributes: The radiation is emitted from the nuclear fuel such as uranium used in the nuclear power generation. The radiation is also emitted from the universe and from naturally radioactive materials, so we are somewhat exposed to radiation in daily life. Due to its penetrability attribute, radiation is also used in medical therapy or non-destructive tests. But if excessive radiation penetrates the human body or crops, it may have negative effects. So the nuclear power generation should make full safety measures against natural and artificial disasters, and should be thoroughly managed in order to not release radiation or radioactive materials. (Tokyo Shoseki, p.204)

In the case of South Korea, six of the ninth-grade junior high science textbooks deal with nuclear power energy; they explain it as an energy-providing source in units related to electricity:

Power plants generate electricity by hydropower, thermal power, and nuclear power technologies. Electricity generated from power plants is supplied to households or factories through power lines. What would be an efficient way to transmit the electricity generated by the power plants? (Kyohak, p. 236)

Nuclear power generation: It converts nuclear energy to electric power. (Chunjae, p. 172)

Nuclear power generation: It is a type of generation method that produces electricity through a generator that is spun by high-pressure stream. The heat energy created in the process of nuclear fission creates this high-pressure stream.

Nuclear energy: Energy generated during nuclear fission or nuclear fusion. (Visang, p.175)

The coal or oil that we often use as fuel is non-renewable once it is used. Moreover, there are finite amounts of these materials. Therefore, energy resources should be conserved or used more efficiently for the future of mankind. Types of energy from nature, such as nuclear, solar, wind, and wave-power energy, as well as alternative energy forms such as bio energy or waste energy, should be developed. (Dubaebook, p.165)

(Excerpt from a supplementary reading) Today, various countries are more interested in nuclear power due to the influence of high oil prices and the demand for the reduction of greenhouse gas. The U.S.A. and Italy, where nuclear power was at one time banned, have decided to build nuclear power plants. Canada, Japan, and China are also building additional nuclear power plants. (Mirae-n, p. 251)

> The electric energy we use is generated mainly by fossil fuel or nuclear power. As such (fuels) are finite, we should conserve electric energy and use it efficiently. Using less electric energy and using it more efficiently together enable resources to be conserved and to reduce the damage caused by global warming, because doing so will produce less carbon dioxide. (Doosandonga, p. 272)

As stated, unlike in the Japanese science textbooks, where scientific and technical nuclear power generation information is included, the Korean textbooks only describe it simply as an energy source. Content related to radiation is not included, nor is content regarding safety. Also, except for one case, there is no information about the use of uranium as a raw material.

2) Analysis of Social Studies Textbooks

When comparing all the textbooks of China, Japan, and South Korea, it was noted that content related to nuclear energy or related issues was not included in the social studies textbooks of China. Although there is a unit that covers resources in the ninth-grade 'history and social studies' textbook, it mainly covers resource issues caused by population growth and does not contain any material about nuclear energy. In the case of South Korea, ten of the eleven selected ninth grade social studies textbooks mention nuclear power or nuclear energy, but only two of them have this content in texts, while the rest provide partial information in the form of either graphs and diagrams, or figures diagrams.

[Figure 10] is an example of a figure in Korean social science textbooks and it reads "In the future, energy resources from sun, wind, water, nuclear will replace the role of oil and coal." This shows how texts in Korean social science textbooks negatively, but only implicitly so,

describe the environmental impacts of oil and coal and their characteristics of being finite, and regard nuclear energy as an alternative energy source

.

[Figure 10] An example of a figure that mentions nuclear energy along with solar, wind, and hydro power

In terms of the frequency and quantity of nuclear energy-related contents, Japanese social studies textbooks have the most content. Of Japan's social studies textbooks on geography, civics and history, all include nuclear energy or nuclear power contents, with the exception of their history textbooks. [Table 16] below shows the chapters in which nuclear energy-related content is included.

[Table 16] Comparison of headings of the nuclear energy-related sections in social studies textbooks

	Subject	Headings (publisher)
China	None	
Japan (published in 2012)	Civics (7 publishers)	♦ Resource·Energy Issues (Tokyo Shoseki) ♦ In order to realize the 21st century(KyoikuShuppan) ♦ Livelihood and Resource·Energy (Kyoiku Shuppan) ♦ Local Government by Residents (Shimizu Shoin) ♦ Population Growth and Finite Resource, (Shimizu Shoin) ♦ To live with Earth Together (Teikoku-Shoin) ♦ The Characteristics of the Modern Society We Are Living in (Nihon Bunkyou Shuppan) ♦ Humans' Response toward Earth Environment (Nihon Bunkyou Shuppan)

		⬧ Aiming at Sustainable Society (Nihon Bunkyou Shuppan) ⬧ For the Future of Humans (Jiyuusha) ⬧ State and I (Ikuhosha) ⬧ Constitution of Democratic Politics (Ikuhosha) ⬧ Resource·Energy Issues (Ikuhosha)
	Geography (4publishers)	⬧ Japan's Resources (Tokyo Shoseki) ⬧ The Development of Industry and Changes in Regions (Tokyo Shoseki) ⬧ The Northeastern Districts (Tokyo Shoseki) ⬧ The Characteristics of Resource and Industry (Teikoku-Shoin) ⬧ Diversity and Economic Development in Asia (Kyoiku Shuppan) ⬧ Overcoming Natural Disasters (Kyoiku Shuppan) ⬧ Unfair distribution of Resource and Energy, (Kyoiku Shuppan) ⬧ Japan from the perspective of Resource and Environment (Nihon Bunkyou Shuppan) ⬧ The Northeastern Districts (Nihon Bunkyou Shuppan) ⬧ The Central Districts (Nihon Bunkyou Shuppan)
South Korea (published in 2012)	(Grade 9)Social Studies	⬧ Energy Resource (Daekyobook) ⬧ Efforts to Obtain Resources (Bobmunsa) ⬧ Different Environmental Problems in Different Regions (Chunjae)

As mentioned earlier, all of the seven selected Japanese civics textbooks include content related to nuclear energy. These contents are commonly covered within chapters that deal with resource and energy issues of the international society. Also, all of these textbooks cover the Great Eastern Japan Earthquake of 2011, at least in their footnotes. While Korean textbooks implicitly list nuclear energy as an alternative energy source against fossil fuel energy sources such as coal and oil, most of the texts in Japan's civics textbooks explain that although it has been a national policy to push forward with nuclear energy policy due to the advantage that it does not produce carbon dioxide, a review process for nuclear power generation and nuclear energy policy is underway due to the Fukushima nuclear power plant accident of 2011. Although the text mentions the safety issues of nuclear power plants, the focus is not on the difficulty in nuclear

waste disposal or on the social and political conflicts on decision making process, and rather on the efforts to secure public acceptability. Some translated excerpts are as follows:

> Japan's electric power is supplied by hydropower at 8%, thermal power at 62%, and nuclear power at 29% (as of 2009). In particular, nuclear power can generate a great deal of energy with a small amount of fuel, which is provided by a stable supply from abroad. In addition, the fuel can be reused many times and it does not emit carbon dioxide during the process of power generation. However, in dealing with radioactive material, if an accident occurs, the damage can be expected to be extensive. Thus, strict safety measures are required. Furthermore, the location of a nuclear waste facility remains an issue. (Tokyo Shoseki, p.167)

> The East Japan Earthquake which occurred on March 11, 2011 brought the maximum amount of damage since the war. The earthquake disaster and the subsequent nuclear power plant accident still have a critical impact on many people's lives. (Kyoiku Shuppan, p.7)

> Japan mainly relies on thermal power, nuclear power, and hydropower generation. Thermal power generation is a relatively efficient method, but it releases a large amount of carbon dioxide. Although nuclear power generation emits less carbon dioxide and accounts for a large proportion of the total amount of electricity generated, there is a strong opposition to the establishment of nuclear power plants due to anxiety over accidents and radioactivity. (Teikoku-Shoin, p.198)

All four of the selected Japanese geography textbooks include content on nuclear energy, and nuclear energy is introduced as the main source of energy in the unit titled "Japan from the World's Perspective" and similarly in the units related to northeastern districts or units on energy and resource issues. One textbook mentions the fact that nuclear power provided from nuclear power plants is supplied to regions outside the local community, which can be expanded to the discourse of environmental justice. Also included are issues related to safety and to radioactive waste management:

> At present, while the demand for electricity has been drastically increasing, thermal power generation using oil, coal, or natural gas as fuel or nuclear power using uranium as fuel has become central to power generation. …

> When it comes to nuclear power, it can efficiently provide stable power without greenhouse gas emissions, but securing safety and dealing with the final disposal of radioactive waste remain major challenges. (Tokyo Shoseki, p.146-147)

> Japan's power is dependent on power generation by thermal, hydropower, and nuclear power. … Nuclear power plants are located in coastal areas because they use seawater to cool the equipment. They can efficiently generate power without carbon dioxide emissions, but there are continuing issues such as the risk of an accident or the determination of a suitable location for a final disposal facility for radioactive waste. (Teikoku-Shoin, p.149)

> In addition, there are nuclear power plants in Wakasa Bay in Fukui Prefecture and in Niigata Prefecture in the central region. Many of these nuclear power plants have been supplying power not to the local community but to the Kinki and Kanto regions. (Nihon Bunkyou Shuppan, p.227)

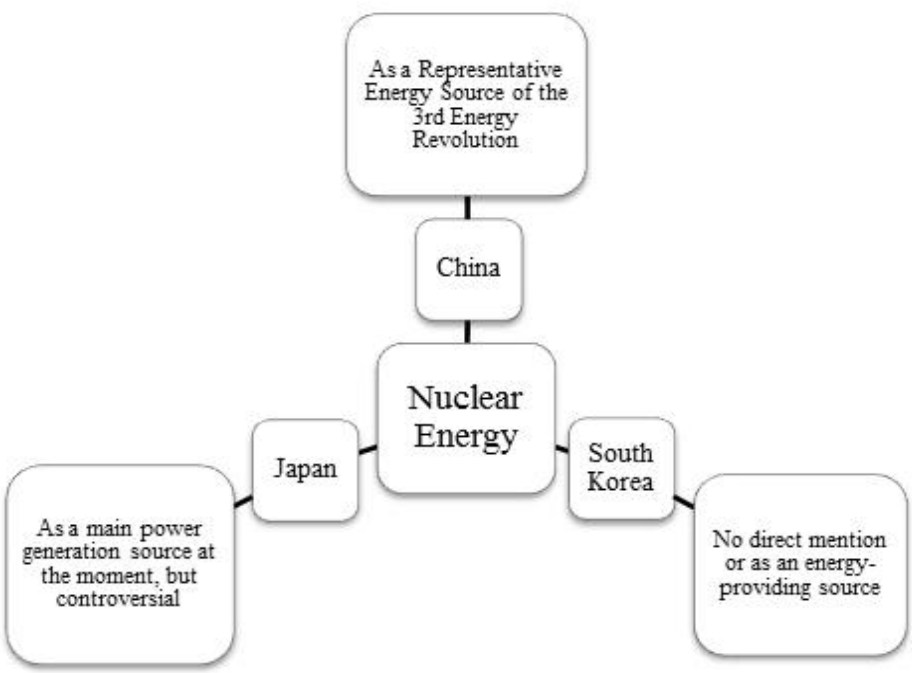
Among the two social studies textbooks of South Korea, one textbook indirectly refers to nuclear energy as a new and renewable type of energy that does not greatly affect the environment, while the other directly distinguishes it as a new and renewable energy, as follows:

> Most greenhouse gases, a major cause of environmental problems, are emitted due to the use of fossil fuels; therefore, it is urgently required to reduce the consumption of fossil fuel energy. Thus, we should use clean energy with lower carbon dioxide emissions, such as natural gas or a new and renewable energy that does not greatly affect the earth's environment. Such energies are nuclear power, hydropower, and solar power. Although the rate of use of new and renewable energy types continues to grow in Korea, it is still low compared to developed countries. (Bobmunsa, p.30)

> Nuclear power generation, which uses uranium fuel, can generate a great deal of power using a small amount of the fuel and generally produces less greenhouse gas. Nuclear power plants are mostly located on stable ground or near the sea or a river in order to ensure a feasible cooling water supply and higher levels of safety. They sometimes experience an unexpected accident, and difficulties can arise when coping with waste disposal issues. … (p.23). The cases in which our government and enterprises participate in (alternative) resource development overseas are increasing, and, recently, a policy to develop more new and renewable energy sources and to increase the share of nuclear power generation is being pursued (Daekyobook, p.21).

Furthermore, another textbook by the Chunjae Publishing Company contains an explanation of nuclear energy as generated by nuclear fusion in its further reading material. It reads, “Energy that is equivalent to thousands of liters of fuel can be produced with a gram of raw material, and it is a green energy source of the future that generates minuscule waste products compared to the nuclear fission method.”

In conclusion, texts about nuclear energy in both science and social studies textbooks of three countries show clear differences in terms of not only the amount but direction of the related explanations. [Figure 11] presents the different paradigms of nuclear energy reflected in the textbooks.



[Figure 11] Comparisons of nuclear energy paradigms reflected in middle school textbooks

V. Discussion

In sum, almost all of the three examined countries' textbooks contain energy-related contents in their two major subjects—science and social studies—of compulsory education. This signifies the evolving nature of the national curricula, in that they tend to revise the contents of textbooks to reflect new social and scientific demands (NIER, 1999). The only exception here is social studies textbooks of China where no energy-related information is stated. This is presumably due to the country's issue of population increase; indeed Chinese social studies textbooks mainly focus on population growth problems when discussing natural resource-related issues.

When examining the similarities and differences of the energy-related texts in the three countries' textbooks, it is seen that the most significant difference lies in the national interests of the countries, and thus their individual approaches to energy-related information. In the results section of this study, the different arrangements of energy-related knowledge and the different key words dealing with energy-related information as they appear in the texts have been discussed to show how each nation has a different interest and thus approach. Among the significant key words and interests that are discussed in the textbooks are: the issue of increasing human population from the perspective of resources in China; Japan's experience of energy-related crisis resulting from high international oil prices in 1973 and the Fukushima nuclear disaster in 2011; and low carbon green growth policy in South Korea.

The increasing population of China, coupled with urbanization, has been much discussed as one of the greatest challenges for the nation as it

grows economically and requires energy to sustain this growth (Ni and Johansson, 2004). In the field of energy policy and economics, energy consumption and preparation for a secured energy supply are considered crucial factors for not only meeting domestic needs but also mitigating adverse effects on global energy markets (Crompton and Wu, 2005). In this regard, China is at work to establish an energy production that is sustainable and dependable (Jiang, 2008). The key elements of Chinas energy development approach are improving energy efficiency, diversifying development technologies, and mitigating pollution (Jiang, 2008). This academic and political discourse is also reflected in the examined Chinese textbooks, especially when describing the requirements for future energy.[17)]

Consequently, the energy discourse reflected in textbooks puts emphasis on population growth not only because it is a significant social issue but is also the most challenging factor when it comes to meeting the need for continuous economic growth from economic and political perspectives. In this regard, the texts deliver the sense of high dependency on energy production technology and a pro-nuclear energy attitude seems to be the "only option" as stated in one of the Chinese textbooks.

While China is in the process of economic development, Japan is already an economically developed country with the largest import of LNG, the second largest import of coal and the third largest import of oil in the world (EIA, 2012). In the work *Energy Security in Asia,* Japan's energy issues are explained under the sub-title of "Resource-starved Japan," which shows how the nation lacks domestic energy resources (Wesley, 2007). Due

17) In the grade ninth physics textbook, it is stated: "First, it must be abundant enough, ensuring long-term use; second, it must be cheap enough, guaranteeing that most people can afford it; third, the technology must be mature, ensuring large-scale use; and fourth, it must safe and clean enough, making sure that there is no serious impact on the environment. Students are the ideal future energy explorers and users."

to its lack of energy resources, Japan has been one of the major oil importers in the world, and among the industrialized nations it was Japan that “suffered the most precisely because of its resource-poor status” from the oil price increase in 1970s (Wesley, 2007). Relating to this, Japanese textbooks, especially social studies textbooks, tend to begin with the nation’s “oil shock” when discussing energy-related issues whereas many of Chinese and Korean textbooks do not mention it. For example, one Japanese textbook explicitly relates the oil price increase experience with the need for nuclear energy by stating “[s]ince the oil crisis in the 1970s, the oil price rose and it became difficult to secure a stable supply of energy sources. Thus, Japan has introduced nuclear power and natural gas in an effort to diversify its energy sources” (Tokyo Shoseki, p. 166). In fact, the Japanese government has been an active and major nuclear actor along with South Korea in East Asia. In comparison with South Korea, however, Japanese textbooks have much more contents in relation to nuclear energy and even include the 2011 Fukushima accident when explaining nuclear power. Nevertheless, the Japanese textbooks label the disaster as ‘the Great Eastern Japan Earthquake in 2011’ not as 'the 2011 Fukushima Nuclear Disaster', which potentially veils the controversy over nuclear power. However, in general, it can still be concluded that Japan’s early exposure to an energy crisis has led to its mature energy discourse; thus Japanese textbooks have the most energy-related contents with the most balanced perspective when compared with those of the other two nations - China and South Korea.

In the case of South Korea, the national textbooks explicitly introduce the nationally promoted low carbon green growth policy and show the governmental strategy to use the energy-related issues as a chance to become a leading country. A statement from the text which reads, “We, too, should pay more efforts to get ahead (among other nations) in the era of

new and renewable energy" (Kyohakyoungusa, p.18) is a representative example of such intention. South Korea is known to be one of the leading countries in Asia that promote green growth policy, and a number of related plans and projects such as the Green New Deal and the Four Major Rivers Project have been initiated by the central government, namely the Lee Myung-bak government. However, there is an opposing national discourse that has questioned the direction of the Lee Mung-bak government towards achieving sustainability, arguing "[green growth] represents a step backward from sustainable development because it replaces sustainable development policy with a model of economic development that uses the environmental industries without actually greening society (Moon, 2010)" The discourse also points to the lack of much needed introspection and reflection on the concepts of development and growth in South Korean public policy making (Yun, 2009). Such opposing arguments are not reflected in the South Korean textbooks. Furthermore, one of the most controversial aspects of the South Korean government's Five-year Plan of green growth strategy is its nuclear energy policy. The government has been promoting and increasing the share of nuclear energy in the total electricity generation of the nation from 24% to 32% in 2020 (Moon, 2010)[18] despite strong anti-nuclear movements that have been more activate in South Korea since the 2011 Fukushima accident. This controversy is, again, not reflected in any of the textbooks, while nuclear energy is explained only briefly.

Aside from the common characteristic of presenting energy-related information in strong conformance with prevailing national interest, the examined text books of all three countries are well focused on the general energy issues. In particular, when looking at consolidated contents from all

18) In 2011 nuclear energy had a share of 29% of the total electricity generation in South Korea. See: http://world-nuclear.org/info/inf81.html

textbooks on the two subjects, general concerns toward energy issues are demonstrated in the cases of all countries. In particular, it is commonly presented that fossil fuels are derived from limited natural sources and that they have environmental impacts. Also, the discussions of finite resources tend to lead to discussions of the need for new and renewable energy. Furthermore, the close relationship between humankind and energy, especially concerning electric energy-related contents, is generally emphasized in science textbooks. On the other hand, social studies textbooks tend to discuss energy issues in relation with resource-related contents, which shows the different approaches used for each subject when handling energy-related contents. All of these observations suggest that energy is closely associated with sustainability for mankind.

Another point of agreement among the three nations' textbooks in terms of energy-related content is their attitudes toward science and technology. In the case of China, energy-related content is mainly delivered in science textbooks, and these textbooks explicitly demonstrate the development of new energy sources as a 'revolution' that has led to human progress, even declaring nuclear energy as a third energy revolution. This is in fair agreement with White's (1943) view on energy, which regards energy as the major driving force for cultural development. In fact, White demonstrated his belief in nuclear energy as a new energy source in his work (1943). Again, this is presumably so because White presented his ideas at a time preceding the global discourse of interlinked energy and environmental sustainability issues. Regarding the reflection of today's social and environmental concerns toward science, Chinese science textbooks include a science, technology, and society (STS) perspective after each chapter, as mentioned in the results section. In the case of the energy-related chapter, for example, it discusses controversial issues such as

landfill issues of nuclear waste disposal and the danger of nuclear reactors, ultimately concluding however that accidents are not likely occur unless there is an external attack and that, therefore, nuclear energy can be seen as a choice for humans to overcome the current energy crisis.

In the case of Japan, all science textbooks too have a STS approach toward science in that they include the theme as an independent chapter. In fact, among the textbooks of the three nations, Japanese textbooks show the most balanced viewpoints between energy and people's energy use, as they frequently incorporate environmental issues. Nevertheless, the development of scientific technology, particularly in the field of alternative energy technologies, in the effort to safeguard the environment is presented as a conclusion in most cases, thus not providing students with the opportunity to holistically comprehend the relationship of humans and nature and develop a keener perspective on energy through ecological rationality.

South Korea, of course, is not an exception when it comes to taking an optimistic view of science and technology. South Korea has the least STS-related content in their science textbooks, and the textbooks to not adequately present the relationship between energy use and its environmental consequences. The texts instead focus on the development of new and renewable energy sources as well as the efficient use of energy.

When the texts are considered as legitimate representative mediums of the national discourse, it may be inferred that all three nations do not tend to discourage energy consumption; rather, it seems as though the texts promote the consumption of energy-efficient technology such as LEDs. This becomes clearer when examining the textual contents related to electric energy. The daily use of electric energy is discussed in independent units that are typically titled 'electricity' in the texts of all three nations, and only

the efficient and safe use of electric energy is encouraged. Another important implication is the target group on whom the responsibility for energy use is shifted. Especially in the units related to electric energy, students are encouraged to efficiently use electric energy with concern to a world energy crisis. Of course, individuals' new attitudes toward the efficient use of energy are necessary in building a sustainable society. Nevertheless, there are other important agents that use much of energy so as to sustain the current political, economic, and social cultures such as: governments and local authorities; markets that use energy in the course of sales; and multinational corporations (Dias et al., 2004). In other words, texts pertaining to energy consumption and efficiency do not put emphasis on the current market system that requires much energy to maintain, and rather focus on the importance of individual's efficient use at homes.

[Table 17] below summarizes the similarities and differences among three nations discussed so far.

[Table 17] Summary of similarities and differences of energy-related information in the school texts of China, Japan and South Korea

<table>
<tr><th></th><th>Similar content</th><th>Different interests reflected</th></tr>
<tr><td>China</td><td rowspan="3">- General concerns toward energy issues in relation with environmental problems
- Finite resources
- The need for new and renewable energy sources
- Safe and efficient use of electric energy
- Optimistic attitude toward science and technology</td><td>Population growth and finite natural resource problems</td></tr>
<tr><td>Japan</td><td>Japan's energy crisis experience of the 1970s as well as the Fukushima nuclear disaster</td></tr>
<tr><td>South Korea</td><td>Regional conflicts as a result of finite natural resources and low carbon green growth as an opportunity</td></tr>
</table>

The examination of the curricula and textbooks of each country in this study shows that most of the energy-related content in the textbooks is

presented in accordance with national curricula. This finding appears to be consistent with what was discussed earlier in the theoretical background section: China, Japan, and Korea are typical countries with "highly centralized" education systems in terms of not only their curricular systems, but also their textbook systems (NIER, 1999 & KICE, 2011). In other words, the central governments set guidelines regarding what is to be taught at schools, and they have control over what is written in their textbooks. This becomes even clearer when looking at the general patterns of the textbooks published by different publishing companies. In the cases of Japan and South Korea, all existing textbooks from all publishing companies were collected and examined, and the examination of the arrangement of the energy-related in all the textbooks shows a similar pattern.

As discussed earlier, a CDA inquiry begins with the conceptualization of a critical question on the existing social conditions (Hyland & Paltridge, 2011). In this regard, in the present study the role of the centralized education systems in China, Japan, and South Korea in dealing with energy issues was questioned, as energy issues are of crucial concern to each of these nations. With this critical question, the CDA approach of energy-related contents in the present work has examined not only the texts *per se* but also the political power nuances woven in the texts in the textbooks through analyzing the curriculum and textbook systems and the current political and academic energy discourse. Through the process, the power relations of texts have become more visible and thus the approach can provide an explanation for the designed, or legitimate, knowledge within textbooks and curricula. Nevertheless, this analysis does not examine how these texts may influence the students of this knowledge.

Furthermore, the competence of teachers and multiple readings by students are also valued variables in talking about the educational impact.

However, it may be assumed that due to the educational and social significance of school textbooks in China, Japan, and South Korea, the texts in textbooks indeed play a significant role in shaping the ideology and possibly even the future choices of students, and this might be the reason why the governments of these countries insist on having centralized, tightly controlled and prescriptive educational systems.

Texts by "power" show "ideological use discourses" of and for "power" (Lemke, 1995). It is seen in the study that texts in textbooks are controlled and manipulated by certain groups with their interests due to the existence of centralized curriculum and textbook systems (Apple 1996; 2004). In this regard, all of the similarities discussed in this section represent an important implication for global politics and global educational environments: a globalized educational system is being built upon a globalized scientific way of thinking of "elites" that pursue continuous economic development (Apple, 1996). This implication is in accordance with one important claim from the field of sociology of education that "analysis of the educational system cannot be separated from some explicit or implicit analysis of the purpose and functioning of the government sector" (Morrow and Torres, 1995). Furthermore, the findings of the present study reaffirm Apple's approach to education that sees education as an inseparable component of power (Apple, 1991; 1992). The present work shows that such a claim is also relevant when discussing national education on energy and environmental issues. In case of China, Japan, and South Korea, the citizens are required to learn the designed knowledge under the title of compulsory education written in standardized languages. Instead of being encouraged to observe the world from the perspective of complex interrelationships so as to envisage their own understandings of sustainability (Huckle, 2011), students are taught to believe the presented facts, which

vary depending on the national political and economic interests, in order to become “culturally literate” in the globalized economy (Apple, 1996; Lemke, 1995).

In the beginning of this work, it was argued that energy education should be able to facilitate the development of ecological citizenship, which indicates the need for a new paradigm of education. The current education or the normative form of schooling, whose goal is to teach the “literacy code” of the dominant mainstream cultures, provides little opportunity for students to nurture their own competence to come up with creative ideas. A new concept of education, or a regulative form of schooling, deals with the encouraged and fair participation of different groups with different interests, which enriches and diversifies the learning processes. Such a way of learning can provide students with the opportunity to develop their ecological competence which challenges the industrial or capitalist rationality “in the name of an ‘ecological rationality’” (Torgerson, 1999).

This ultimately raises questions of not only environmental sustainability, but also “of the interests, rights, and value of nonhuman nature [as] much part of the green agenda” (Torgerson, 1999). Dryzek (1997) also notes the need for environmental discourse “to be positioned in the context of the long-dominant discourse of industrial society.” The discourse reflected through energy-related contents of the studied textbooks, however, does not show consideration of the interests, rights, and values of politically and economically disempowered members of society. As Odum (1981) acknowledges, the current political-economic system of mankind can source materials and fuels to sustain populations and cultures, the realization that, however, “human beings are only a small part of the great biosphere of oceans, atmosphere, mountains, valleys, land, rivers, forests, and ecological component,” (Odum, 1981) is the beginning of ecological

rationality that ultimately leads to the reflective discussion of sustainability. Ecological empathy and rationality may lead to the formation of ecological citizenship which regards justice as the fundamental virtue (Dobson, 2003).

Energy education should be, therefore, approached more holistically, incorporating knowledge of the various aspects of global living on a finite planet, so as to contribute to the sustainability diverse natural and human cultures.

Ⅵ. Conclusion

This study was aimed at examining the energy discourse reflected in national textbooks in China, Japan, and South Korea with critical discourse analysis as the main methodological approach so as to initiate the discussion of energy education in Asian region. The hypothesis and the theoretical background of the study were influenced by Apple's critical understanding of texts that are "caught up in a complicated set of political and economic dynamics" (Apple, 1991). Thus, it was stated that texts with regard to energy-related content in the three nations' textbooks would reflect the current national political, economic, and social conditions, particularly due to the characteristic of a state-driven curriculum, which is aligned with each nation's political, economic, and social cultures and traditions (Apple, 1979, 1982a; Beyer & Apple, 1988). One hundred and eleven science and social studies subject textbooks were examined, and the summary of key results is presented in this section by answering the eight research questions raised in the earlier section.

First, although the present inquiry is closely related to text and discourse analysis, as the research data are textbooks, two questions regarding quantitative analysis of textbooks have also been raised to satisfy the characteristics of comprehensive methodological approaches for textbook research as stated in the UNESCO Guidebook on Textbook Research and Textbook Revision. Among the one hundred eleven textbooks, only the forty six textbooks that contain energy-related contents were chosen, which are mostly ninth grade textbooks. In the examination of the textbooks to answer the two quantitative analysis questions - *how many times is a term related*

to energy used or mentioned in the textbooks and *how much space is allocated to the relevant topic* - it was found that science textbooks mention 'energy' more frequently than social studies textbook in the case of all three countries, and at least one or two independent sections in the textbooks have been allocated to energy-related contents either from the material-perspective or STS perspective in science textbooks. On the other hand, social studies textbooks mostly discuss energy-related issues in the sections dealing with resource-related contents, thus one sub-section is usually dedicated to energy-related contents, with exception of Chinese social studies textbooks.

The third research question is concerned about how the energy-related text is positioned or positioning the energy-related issues in nationally designed textbooks. While the energy discourse in the textbooks of the three countries shows a certain similarity in that the discourse is built upon the globalized political and economic ideologies of an industrialized society, there are some differences in terms of the arrangement of energy-related contents which are closely aligned to each nation's interests. Energy is, in short, discussed primarily as a power-providing source for the objective of economic growth, as well as sometimes mentioned in relation to resource-related issues with some environmental concerns, especially in social studies textbooks. This leads to the discussion of the next research question which is related to the authored interests being served by such positioning. The authored interests – mainly the interests in maintaining current political and economic cultures – implicitly or explicitly guide the students to realize the importance of new and renewable energy sources, which sometimes include nuclear energy, and the efficient use of energy while providing only little impetus to reconsider the relationship between the global market system and the complex global ecological system.

In this process of ascertaining the authored interests, it is also evident whose interests are being negated, which is the fifth question of this study. The conspicuous lack of reflective dialogue on the complex interrelationships of global energy availability and use with ecological and social justice, values and prudence, compounded with a somewhat myopic emphasis on limited and centralized forms of energy technology, indicate that the interests of dissenting voices, such as anti-nuclear researchers, environmentalists and disempowered members of society are clearly negated in the energy-related contents of texts of the three countries.

The next question - *what are the consequences of this positioning?* - is also relevant in discussing the significance of the results. An anthropocentric focus in the discussion of energy-related contents in educational textbooks may serve to eventually rationalize and sustain the prevailing process of economic growth and the concentration of political and social power; this inhibits the development of ecological citizenship or competence, which has been highlighted as a key precept and the ultimate objective of energy education. In answering the next question - *how are the students considered in the process?* - the study finds that students are regarded as: the willing recipients of such "legitimate" knowledge as prescribed by the educational curricula, which in turn are maneuvered by national interests; the individual energy consumers with the responsibility to efficiently use energy; and sometimes as the future scientists who can contribute to the world by developing advanced energy technologies.

Finally, with the research questions answered above, it can be concluded that ecological citizenship is unlikely achieved in the current educational environment as what is being taught at schools is in accordance with the interests of the mainstream political economics. In other words, the implicit and explicit messages in the energy-related contents do not seem to

provide an alternative and holistic approach to understanding the complex interrelationship between an ecological system and a human society. The examined textbooks rather show the integrated relationship between energy education and the political culture of the globalized world, as represented in the educational actions of individual countries, which is a critical sign of environmental policy failure in the long term, since "environmental policy failure can be traced to structural contradictions in the capitalist economy, which are analyzed as giving rise to crisis tendencies (Eckersley, 2004)."

By coalescing sociology of education perspectives into the ideas of green politics with a critical discourse approach, this study examined how the predominance of globalized economic and political systems upon national educational agendas is reflected in school textbooks. The examination found that the absence of holistic and deeper ecological connections, as well as the lack of a requisite balance in the textual representation of assenting and dissenting voices on the scope of human's technological future and sustainability, seem to be, in a greater scope, in line with Apple's point toward the relationship between power and culture. He argues that schools' control over 'citizens must have' knowledge is to distribute legitimate knowledge related to the prevalent power's political and economic arena. Through schooling 'citizens must have' knowledge becomes 'knowledge for all' (Apple, 1979). Therefore, power and dominant culture are facets of the current economic relations in a human society. The current educational systems have become involved in the creation of dominant cultural practices, especially in promoting industrialization without social realization. These educational systems are marked by the lack of interactive learning curricula that can engage students to re-examine the foundations of energy prudence, thus developing their ecological citizenship or competence. Environmental and energy crises are signs of the need for essential changes in the existing

paradigms of understanding the relationship between human and nature, which should begin from the comprehension of the existing man-made systems.

Hence, this work might have critical implications for those who would like to approach sustainability issues from a reflective and holistic understanding of ecosystem and human society, as well as for those who emphasize the rights and interests of future stakeholders that can be informed by such an integrated understanding. This work, on the other hand, may have less significance for those whose interests lie in maintaining the prevailing power structures of the globalized system.

Also, a few limitations of the study can be seen as obstacles in making the argument more credible. The first limitation of the study is of course the possibility of multiple readings when approaching texts as Apple (1992) also clearly states in his work. In addition, because this study tried to see the overall patterns and organizations of the energy-related texts in textbooks, detailed analysis on each key term or some significant sentences have not been attempted. The absence of Chinese textbooks from all publishing companies is also another limitation of the study. Being a researcher of South Korean background may be another shortcoming in understanding the texts and of relating the texts with the existing discourse in depth. In this regard, therefore, more studies and research on energy education especially in the three major energy consumption countries in the East Asian region, from more varied perspectives - social, economic, cultural, political, ecological, and educational - with various methodologies are left for future research.

In particular, understanding the impact of the Fukushima nuclear disaster of 2011 on the nature of the energy-related texts through comparing older textbooks with newer ones or the changes in energy-related contents in

each nation's textbooks is another interesting subject for further research.

In addition, there are three primary areas of further inquiry that are related to the present study. First, more academic inquiry is needed into examining the predominance of the globalized system on the nature and direction of environmental education, and thus on our future generations. Second, it is equally pertinent to understand how students would be influenced by narrow educational messages on energy issues. Third, perhaps most significantly, interdisciplinary experiential research of pedagogic approaches is necessary to understand how students can be facilitated towards introspection, creativity, and purposeful participation in seeking harmonious co-existential and sustainable societies, through re-imagined, perhaps less consumptive and less wasteful, ways of living.

Obtaining a richer integrative view of sustainability begins with the recognition of the human sources of the characterization of needs for sustainability at every dimension of the current situation on Earth. Hopefully, this study can provide a useful understanding of the process to examine the role of current educational systems in coping with climate change issues and questioning the mainstream's approach in establishing and maintaining the prevailing political, economic, and educational conditions.

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Appendix A

List of Collected Textbooks

China

Social Studies		Publisher
思想品德	七年级上册/ 七年级下册/ 八年级上册/ 八年级下册/ 九年级全一册	人民教育出版社
历史与社会	七年级上册/ 七年级下册/ 八年级上册/ 八年级下册/ 九年级全一册	
地理	七年级上册/ 七年级下册/ 八年级上册/ 八年级下册	
Science		
物理	八年级上册/ 八年级下册/ 九年级全一册	
化学	九年级上册/ 九年级下册	
生物学	七年级上册/ 七年级下册/ 八年级上册/ 八年级下册	
贵阳市生态文明城市建设读本		

Japan

Geography	
Publisher	Textbook Title
東書	新しい社会　地理
教出	中学社会　地理　地域にまなぶ
帝国	社会科　中学生の地理 世界のすがたと日本の国土
日文	中学社会　地理的分野

Civics	
東書	新しい社会　公民
教出	中学社会　公民　ともに生きる
清水	新中学校　公民　日本の社会と世界
帝国	社会科　中学生の公民 よりよい社会をめざして
日文	中学社会　公民的分野
自由社	新しい公民教科書

育鵬社	中学社会　新しいみんなの公民

Science	
東書	新しい科学　1年
東書	新しい科学　2年
東書	新しい科学　3年
大日本	理科の世界　1年
大日本	理科の世界　2年
大日本	理科の世界　3年
学図	中学校科学　1
学図	中学校科学　2
学図	中学校科学　3
教出	自然の探究　中学校理科1
教出	自然の探究　中学校理科2
教出	自然の探究　中学校理科3
啓林館	未来へひろがるサイエンス　1
啓林館	未来へひろがるサイエンス　2
啓林館	未来へひろがるサイエンス　3

South Korea

Social Studies	
Grade	Publishers
사회1	(주) 교학사(김종욱)/ (주)교학사(김주환)/ (주)교학사(허우긍)/ (주)금성출판사/ (주)대교/ (주)더텍스트/ (주)미래엔/ (주)비상교육/ (주) 삼화출판사/ (주)새롬교육/ (주)지학사/ (주)천재교육(노경주)/ (주)천재교육(류재명)/ (주)천재교육(박병익)
사회3	(주)교학사(김종욱)/ 교학연구사(허우긍)/ (주)금성출판사(서태열)/ (주)대교(김학훈)/ (주)더텍스트/ (주)미래엔/ 법문사/ (주)비상교육/ (주)지학사/ (주)천재교과서/ (주)천재문화

Science	
과학1	(주)교학사/ (주)금성출판사/ 두산동아(주)/ (주)미래엔/ (주)비상교육/ (주)천재교육
과학2	(주)교학사/ (주)금성출판사/ (주)동화사/ (주)두배의느낌/ 두산동아(주)/ (주)미래엔/ (주)비상교육/ (주)중앙교육진흥연구소/ (주)천재교육(유준희)/ (주)천재교육(이면우)

과학3	(주)교학사/ (주)금성출판사/ (주)동화사/ (주)두배의느낌 / 두산동아(주)/ (주)미래엔/ (주)비상교육/ (주)천재교육 (유준희)/ (주)천재교육(이면우)

국문초록

한·중·일 교과서 속 에너지 관련 내용에 대한 비판적 담론분석

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December, 2012

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한·중·일 교과서 속 에너지 관련 내용에 대한 비판적 담론분석

김고운
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기후 변화 현상에 따른 각종 재해와 사회 문제는 전 세계가 공유하는 공통의 과제가 되었다. 기후변화협약(The United Nations Framework Convention on Climate Change, UNFCCC)의 제1조에 따르면 “기후변화”는 직접적 혹은 간접적으로 지구의 대기 구성요소를 변하게 하는 인간 활동에 기인하는 것이며 자연적 원인에 의해 기인하는 변화는 “기후변동(climate variability)”이라는 용어로 구분하여 표현하고 있다.

이러한 이유에서 기후 변화 현상에 대한 인간 행동에서 야기되는 요인들이 국제적 차원에서 담론적으로 가시화되고, 기상이변에 따른 태풍·호우 등의 자연 재해가 증가하면서 이를 효과적으로 대응하고 적응하기 위한 국제적 차원의 협력이 지난 20세기 말부터 시작되어왔다. 이 과정에서 중추적 역할을 하는 것은 국가와 기업일 수 있겠지만, 이들을 구성하는 사회공동체의 작은 단위를 따져볼 때 온실가스 감축 및 대안 에너지 사용 등 환경을 고려하는 행위의 가장 기본적 주체는 개인, 즉 시민이 된다. 이러한 의미에서 국가 차원의 기후 변화 관련 교육은 중요한 영향을 가지며, 효과적으로 대응할 수 있도록 교육을 통하여 이러한 전 지구적인 상황을 알리고, 교육의 힘을 빌려 교육적인 측면에서 보다 근본적으로 대처하는 것은 기후 변화 시대의 필수적이고 기본적인 국가의 의무라고 할 수 있다.

그런데 한 가지 주목할 점은 미국 에너지정보청(EIA)이 발표한 자료에 따르면 중국과 일본, 그리고 한국의 2009년 이산화탄소 배출량이 각각 세계 1위, 5위, 9위였다는 것이다(2011). 세계 10위내의 국가들이 배출한 이산화탄소 배출량 합계는 19.0 Gt CO_2로 무려 세계 전체 배출량인 29.0 Gt CO_2의 삼분의 일에 가까운 수치이다. 2008년에는 한·중·일 세 나라의 에너지 소비량이 아시아의 75%를 차지했다. 이는 기후 변화 시대에 여전히 한국, 중국, 일본을 포함한 국가의 온실가스 감축 및 에너지 사용에 대한 전환적 사고를 위한 노력이 동아시아의 그 어느 국가보다 절실히 필요하다는 것을 드러내고 있다. 따라서 이들 3개국에서 에너지에 대한 내용의 교육이 국가적 차원으로 어떻게 이루어지고 있는지는 사뭇 중요하다. 현 지구가 안고 있는 기후 변화에 대한 절박한 상황과 해결책 마련에

미래 세대의 인식을 높이고 책임을 자각하게 만들면서, 교육적인 측면에서 에너지 사용 및 소비의 측면에서 기후 변화 대응 노력을 실천해가는 생태적 마인드의 21세기 시민을 양성하는 일이야말로 이 시대에 우리가 교육을 통해 해야 할 무엇보다 중요한 과업이기 때문이다.

이렇게 교육적 측면으로의 접근은 학생들이 기후 변화 시대의 사회 미래 구성원으로서 그들의 의무와 책임이 중요하다는 것을 깨닫게 도울 수 있으며, 이는 최근에 활성화 되고 있는 새로운 생태적인 비전의 시대로 연결되는 시민에 대한 담론으로 이어질 수 있다. 그 중 본 논문은 공공영역 뿐만 아니라 사적영역에서도 작동되며 생태적 감수성과 정의의 덕목을 바탕으로 하는 생태적 시민성(Ecological Citizenship)을 이론적 바탕으로 삼고 과연 현재의 공교육 현장에서 다루어지고 있는 에너지 관련 교육 내용이 생태적 시민성의 함양에 이바지 할 수 있는가를 질문하고자 한다.

이러한 절박한 지구의 총체적 난국의 환경문제를 보다 효율적으로 교육을 통해 근본적으로 대처하기위한 노력의 일환으로 본 연구는 기후변화시대를 살아가는 현재의 한국과 중국, 일본의 공교육 현장에서 다뤄지고 있는 에너지 관련 교육 내용에 대한 비교 연구를 목표로 하고 있다.

그러므로 본 연구에서 교육적인 측면을 다룰 수밖에 없는 부득이한 상황에서 먼저 한. 중. 일 학생들이 교과에서 교육되어지고 있는 교과내용의 분석이 선행되는 바, 학교 교육은 한 사회의 정치적, 문화적, 경제적 조건과 권력에 의한 담론을 반영하고 있다는 비판적 교육사회학 이론을 가설의 바탕으로 삼아, 에너지 관련 교육 내용이 한국과 중국, 일본의 현 정치 경제학적 특성과 주류 담론을 반영하고 있을 것이라는 연구 가설을 채택하였다. 현 21세기의 총제적 지구적인 상황을 전달하여 현재의 위기와 이를 인식, 인류의 생존과 지구의 안녕을 위해 여러 차원에서 분석하여 학생들로 하여금 미래에 적절하게 대처할 수 있는 지구적인 교육 내용이 이루어져야 함이 마땅한 작금의 시기가 분명함에 충분히 이러한 문제가 교과서에서 다루어지지 못하고 있음은 교과서 속 에너지 관련 내용이 다분히 역사를 이끌어가는 현 시대의 특정한 정치적, 경제적 다양한 조건과 문화적 시대적 패러다임에 의해 구성된 요인이 있을 것으로 보고 이러한 문제점과 연구 가설을 점검하기 위하여 비판적 담론 분석(Critical Discourse Analysis)의 방법론을 채택하였다.

그러므로 연구를 위해 본 논문에서는 한. 중. 일 교과서에 실린 에너지 관련 지식의 설계와 짜임이 어떻게 이루어져있는지 분석하는 것을 우선으로 하였다.

한국과 중국, 일본의 중학교 과학과 및 사회과 교과서 총 111종을 수집 및 검토하였으며, 자료 수집 및 검토 결과 그 중 46권이 에너지 관련 내용을 가진 교과서로 간추려졌다. 따라서 본 연구는 46권에 담긴 에너지 관련 내용의 텍스트를 그대로 발췌하거나 정리하여 연구 결과에 밝히고, 정리된 교과서 속 담론이 어떠한 의미가 있는지 아래와 같은 연구 질문을 하고 있다.

1) 에너지와 관련된 용어가 얼마나 자주 언급 혹은 사용되고 있는가?
2) 에너지 관련 내용이 얼마나 할당되었는가?
3) 에너지 관련 텍스트가 교과서에 어떻게 위치하고 있는가?
4) 이러한 텍스트의 위치에 저술된 권익은 어떻게 충족되고 있는가?
5) 교육내용에서 어떤 목소리가 무시되고 있는가?
6) 이러한 텍스트 위치에 따른 결과는 무엇인가?
7) 이러한 교과과정에서 학생들의 위치는 어떠한가?
8) 생태적 시민성 혹은 생태적 역량이 현재의 공교육 현장에서 체득 가능한 교육적 이념인가?

분석 결과 위의 주요 연구 질문에 따른 연구 결과를 간략하게 요약하면 다음과 같다.

1) 에너지 관련 용어 혹은 내용은 3개국의 경우 모두 사회과 교과서보다는 과학과 교과서에서 잦은 빈도로 언급이 되고 있으며 이는 에너지 관련 내용이 사회학적 측면에서보다 과학적 측면으로 더 많이 다루어지고 있다는 점을 시사한다.

2) 에너지 관련 내용은 과학과 교과서에서 3개국 모두 최소한 한 과(chapter)이상의 공간으로 할애되고 있으며, 사회과의 경우 자원 관련 내용을 다루는 과에서 소단원으로 다루어지고 있다.

3) 3개국의 경우 공히 에너지에 관련된 내용은 산업 사회의 정치적이고 경제적 이데올로기를 반영하는 내용, 즉, 지속적인 경제 성장과 현대의 편리한 생활을 영위하기 위해 필수적으로 필요한 전력 공급원으로써의 에너지로 대개 묘사되고 있다. 자원 관련 내용과 같이 다루어질 때에는 자원의 유한성과 수반되는 환경 문제에 대한 언급도 있었지만, 3개국 모두 생태시스템 안에서 인류와 다른 생명체가 생존을 위해 꼭 필요로 하는 에너지로서가 아닌 세계화되고 산업화된 사회 내에서의 시스템을 유지하기 위해 당연히 필요한 수단으로 묘사되고 있다.

4) 이러한 에너지에 대한 인간중심적 담론 구성은 핵에너지에 관한 내용을 분석

할 때 더욱 두드러지게 드러났다. 111권의 교과서 중 46권이 에너지 관련 내용을 담고 있었고, 그 중 34권만이 핵에너지를 언급하고 있었으며, 중국의 경우는 지속적인 인간 사회의 성장에 핵에너지는 피할 수 없는 선택으로, 한국의 경우는 다른 에너지원과 같은 당연한 전기 에너지 공급원으로, 일본의 경우는 후쿠시마 사고가 발생했지만 자연 자원이 부족한 일본에게 뾰족한 대안이 없는 현재 유지될 수밖에 없는 국가의 제3의 에너지 공급원으로 묘사되고 있었다. 이러한 담론 구성은 현재의 정치 경제 구조를 유지하고자 하는 주류 집단의 이익관계를 역설하고 있으며, 과학기술의 발전에 따른 새로운 에너지원 개발로 인류의 에너지 문제가 해결될 것으로 기술되어 있다.

5) 이러한 담론 구성의 과정에서 환경 정의 혹은 생태계의 우주적 시스템의 가치나 인간의 역사적 출현에 따른 우주적 정체성 등 우주. 지구의 생태. 사회 정의를 대변하는 다른 집단의 담론은 부인되고 있으며, 특히 핵에너지와 관련하여 지구촌 전체로 증폭되고 있는 생태적인 측면에서 환경을 우려하는 목소리 등에 비추어 사회의 다양한 구성원의 담론이 포함되지 않고 있음을 시사한다.

6) 이러한 교과서 내의 담론 구성은 반성 없는 각종 환경 문제를 야기시키는 현재의 정치, 경제적 구조를 반영하고 있으며, 이 시대의 교육환경과 사회적, 생태적 이슈로 문제가 되고 있는 이 시대의 에너지 관련 쟁점사실이 학생들에게 교육내용으로 객관적으로 전해지고 있지 않은 상태이다. 전체적인 담론이 고려되지 않은 교육과정은 미래의 의사결정권자들인 학생들의 교육적 혜택과 환경의 변화에 따른 적응과 생존을 위한 준비를 교육이 보장하지 못하는 결과를 초래할 수도 있다.

7) 생명. 사회(기술, 경제, 정치.법) 문화, 인격, 종교적 가치 등 사회의 모든 분야를 이루고 있는 가치를 통합하여 충분한 담론을 통해 객관적으로 역사 안에서 이루어지고 있는 갈등과 쟁점 사실은 교육을 통해 지식과 지혜의 수여자인 학생들에게 잘 전달되어 지고, 학생들은 생태적이고 지속가능한 효율적인 에너지 사용의 책임이 있는 에너지의 생산과 소비로, 혹은 우주의 역사적 정체성을 겸비한 미래의 에너지 문제를 발전된 에너지 기술로 해결할 수 있는 주체적 역할로 생태적 마인드를 기본으로 역사를 진화시킬 수 있는 '위대한 과업'을 역량 껏 실현해야하는 주체들인 것이다. 그렇지만 교과서 담론 내에서 학생들은 교육 시스템에 의해 합법화된 교과서 속 담론이 형성하는 지식의 수여자로, LED 전구 등을 구매해야하는 에너지 소비자로, 핵융합 등의 기술을 개발할 미래의 과학자 등으로 인간중심적 사회가 요구하는 인재상으로 위치되고 있는 것이 작금의 상황이다.

8) 정리하자면, 권력에 의한 권위적 교육적 담론은 인간중심적인 지식의 범주에 학생들의 배움의 기회를 제한함으로써 본 논문이 이론적 바탕으로 삼고 있는 생태적 시민성 혹은 생태적 역량의 발달의 기회를 방해할 수 있는 요소라고 간주된다.

비판적 담론 분석 방법론의 특성상 텍스트에 따른 해석자의 다양한 해석의 여지를 고려할 때 본 연구는 한 명의 한국 국적을 지닌 연구자가 연구를 진행하였다는 한계점과, 교육 현장에서 실제로 학생들에게 이러한 교육 내용이 어떠한 영향이 있는지에 대한 연구가 선행되지 않았다는 한계점이 있다. 따라서 논문의 결과를 다각적인 학문적 각도에서 점검하고 깊이 연구하기 위해서는 이러한 생태적 관점과 역사적 정체성을 담은 교육을 제공하려는 유사한 연구 주제가 후속적으로 이루어져야 할 것으로 보인다. 또한 3개국의 비교 과정에서 다소 부족하게 분석된 각 국가별 담론의 특징과 주요 용어에 대한 각 교과서 속 틀짓기(frame)가 어떻게 나타나고 있는지도 지속적으로 필요한 연구 주제이다.

본 연구는 기후 변화를 통해 나타나고 있는 지구 생태와 인류 공동체가 오늘날 겪고 있는 문제를 교육을 통해 개선, 지구 생태적인 근본적인 반성과 성찰로부터 희망을 가질 수 있으며, 특히 미래 세대를 포함한 시민들이 함께 총체적인 환경문제 등을 다양한 방법으로 협력해나가기 위해서는 우주적 마인드와 역사 안에 흐르는 다양한 가치를 통합할 할 수 있는 능력, 생태적 시민성과 같은 경제적 가치가 우위를 점하는 산업 사회가 놓쳐버린 다양한 가치의 덕목과 통찰을 바탕으로 하는 역사적 정체성을 겸비한 시민 교육이 시작되어야 한다는 문제의식에서 시작되었다.

정리된 부족한 연구 결과를 통해, 현재의 교육 내용으로는 생태적 시민 교육이 시작되기에 어려움이 있음을 알리고, 한국과 중국, 일본의 사례를 통해 확인된 이미 세계화된 경제를 우선순위로 진행되고 있는 가치를 선택하는 권력 집단의 이익관계가 만연한 현 교육 시스템의 한계점을 있는 그대로 사사, 우리 인류 모두의 생존이 달려있는 지구촌의 환경문제를 교육의 힘으로 해결하는 준비를 하는데 아주 작은 기여라도 할 수 있기를 희망한다.

◆ 주요어 : 비판적 담론 분석 (CDA), 생태적 시민성, 에너지, 환경 교육, 국가 교육과정, 핵에너지, 권력, 텍스트

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