Case Study of K-12 SD program in South Korea

Applied by World Climate

Focused on Environment Subject[1]

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Abstract

Environment subject in K-12 curriculum is inevitable along with global concern about the environmental issue but exceptional in South Korea, stuck in the middle between the legitimacy of environment education and pressure for lessening educational burden of students, Environment subject got lost facing another official government-led amendment in education curriculum of K-12 education in South Korea that will be in act in 2018. Even under the best scenario, controversy concerning environment education leaves issues to be addressed: lack of holistic view, environment sensitivity, and hands-on activity or solution. That is the reason why we devise environment education program focused on systems thinking with World Climate. Application of this program for the middle school proves the possibility of new alternative to environment education even if there is a long way left for Environment subject to embrace systems thinking.

Keywords: K-12 education, Environment education, Environment subject, World Climate, C-ROADS, systems thinking

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3) Nonprofit organization for K-12 SD education, like Creative Learning Exchange

1. Introduction

20 events of the 'World climate-climate change negotiations game" with 580 participants have been held in South Korea, since it was first introduced on August 8, 2016 with 30 teachers of innovative school that Seoul Metropolitan Office of Education granted. The number is on the launch pad for exponential growth due to the surge in demand in 2017. The World Climate is a role playing exercise of the UN climate change negotiations for groups. It uses an interactive computer model to rapidly analyze the results of the mock-negotiations during the event (Climate Interactive). The introduction of the game into the world was the evidence that the importance of the environment is growing. 7 out of 17 agendas of Sustainable Development Goals announced by United Nation in 2015 are dealt with the environmental issue. This implies that the environmental issue is crucial one these days (Hong, 2016).

Need for environmental education has risen accordingly. In 1992 United Nations Conference on Environment and Development (UNCED) suggested that every nation should have specific curriculum and fine methods on environment education. Although South Korea did not attend the conference, in the same year, the Korean government made a pivotal decision: to independently make environment subject in the middle school education curriculum.

This decision was extremely meaningful in some ways. Environment subject as an independent curriculum was the first one suggested from the social and governmental need, because the education on environment was believed to be the fundamental solution for the pollution; this is first event to add new subject in the curriculum since the Korean Independence Day, August 15, 1945(Nam, 1995). Adding new subject in formal education curriculum is very exceptional, because at those time middle and high school subjects are doomed to shrink and be removed for the sake of lessening burden of expenditure and stress on additional education(Seo, 2016). Figure 1 illustrates the mental model of government handling the environment subject.
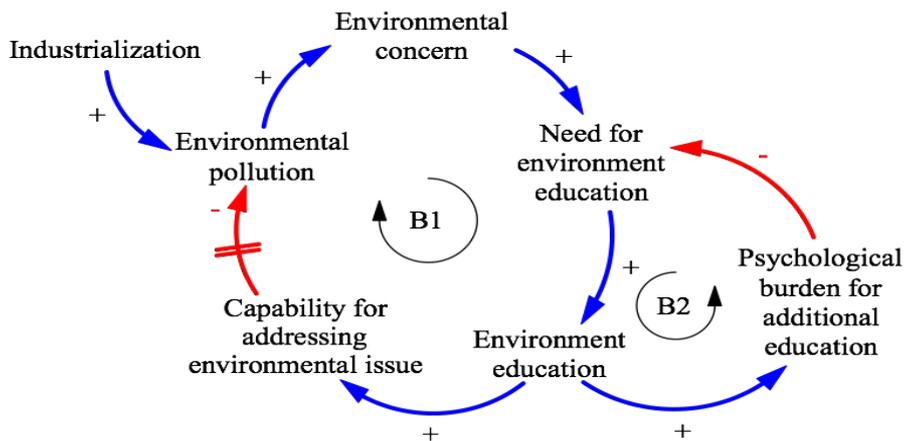
Figure 1. Mental Model of government concerning Environment subject

This paper briefly illustrates the change over time of Environment subject and its limitation. According to the limitation and the goal of Environment subject, we propose a curriculum for the Environment subject applied by systems thinking starting with the World Climate.

2. Literature Review

2.1. Change of goals for Environment subject

The Environment subject has gone through four times of revision. On the first revision in 1997, the Ministry of Education of South Korea announced the goal: to foster adequate values, sensibility, and attitude based on the understanding of the environment and to actively participate in preserving environment based on research for solution of environmental problems (Ministry of Education, 1997).

The second revision in 2007 mentioned environmental sensitivity and the relationship between human and the environment as the goal. The subject's goal was 1) to understand the relationship between the environment and human based on environmental sensitivity, 2) to foster capability to solve environmental problem and to have knowledge about the environment, and 3) to participate in preserving the environment activities based on eco-friendly and sustainable development mindset (Ministry of Education, 2007).

The third revision of 2009 emphasized 1) research on the environment 'within the community' to which students belong, 2) experience of the Environment to foster eco-friendly mindset and environment sensitivity, and 3) 'green citizen' through cooperation and actions (Ministry of Education, 2009).

The latest ongoing revision was made in 2015 to be in action in 2018. It aims for learners to comprehend environment and environmental problem in the context of their lives, and to proactively participate in making sustainable society through integrated environment education. The Ministry of Education has still focused on developing environmental sensitivity, sense of environment community, insight, creative problem solving capability, conflict solving ability, and management of environment (Ministry of Education, 2015).

2.2. Limits of current Environment education

Despite its ambitious goal and nice start, Environment subject was an elective subject rather than a compulsory subject, which is the reason why the adoption rate of environment subject in school is decreasing since 2006(Seo, 2016). Figure 2 shows the decrease of the middle and high school choosing environment subject from 18 percent in 2006 to merely 9 percent in 2015.
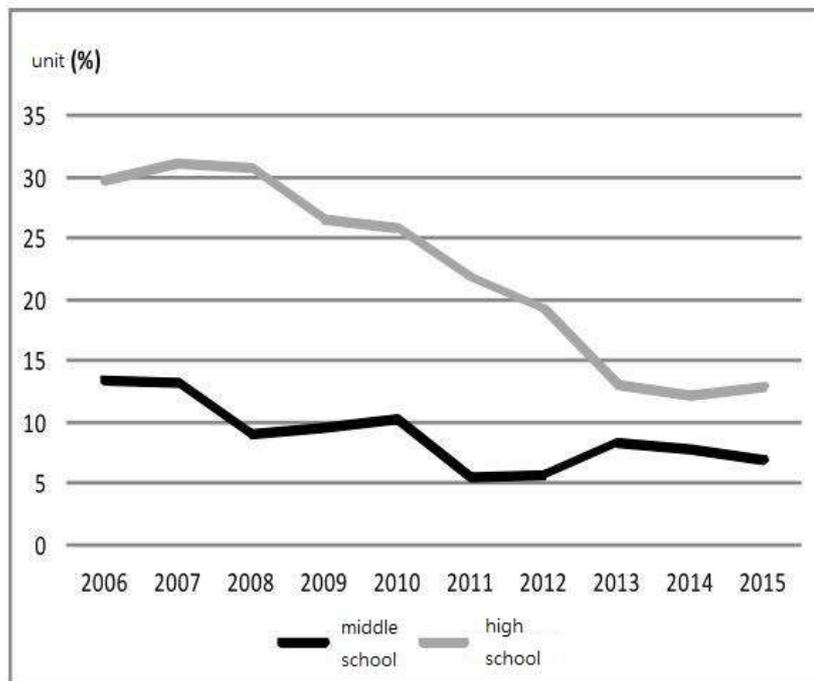

Figure 2.   Declining adoption rate of Environment Subject (Seo, 2016)

The contents of the environment textbook were another major problem in the environment education. While the goal of the environment education declared by Ministry of Education in 2009 was focused on developing environmental sensitivity and actions in real life, the contents of the textbook is too focused on delivering the knowledge and the data(Moon, 2015). According to Lucas who emphasizes three ways of learning the environment: education *about* environment, education *in* environment, and education *for* environment, the environment education could never be successful with the textbook only focusing on learning *about* environment(Lucas, 1979).

The goal of the education is also unmet by textbook's lack of holistic view. The environment education was initiated by the governmental and social need to actually solve the environmental problems(Park, 2001). The current textbook contents are too much focused on natural science and engineering(Kim, 2003; Choi, 2003; Jeong, 2004; Kim, 2005), restricting students to speculate real actions related to mental model of stakeholders and social entities. Shin(2006) found out that students themselves criticized the lack of interconnection and interdependency in the textbook's information.

Lastly, both instructors and learners complained the very lack of hands-on activity in the current environment education curriculum(Shin, 2006). Hands-on activity not only increases education interest, but also helps learners to apply what they have learnt into the real life.

Based on these limitations of the current textbook and overall curriculum, the whole new approach is needed. This paper suggests a new solution for the Environment subject in South Korea applied by systems thinking with world climate-climate change negotiations game.

3. World climate-climate change negotiations game

3.1. C-ROADS

The main program used in the World Climate-climate change negotiations game is C-ROADS or Climate Rapid Overview And Decision Support. C-ROADS literally rapidly overviews the climate data, and supports players' decisions. The program enables audience to easily understand the relation between greenhouse gas emission and its impacts

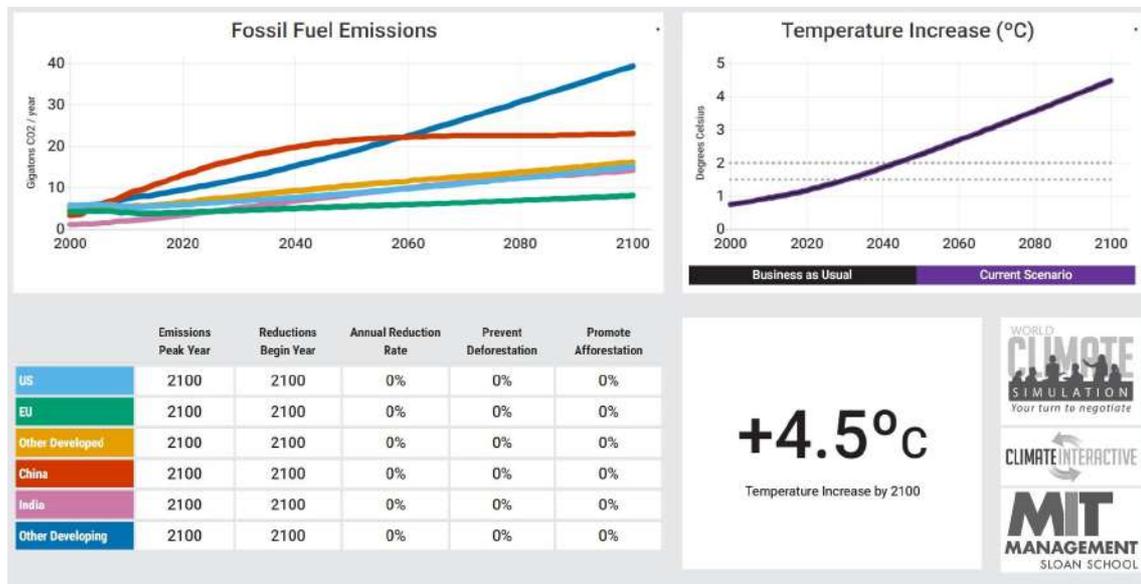on climate, which was hard to grasp even for professionals(Sterman, 2013).

Figure 3. Interface of C-ROADS

Using C-ROADS is simple; players input the data shown in the bottom left of the figure 3. The program then calculates fossil fuel emissions shown on the upper left of the figure 3. At the same time, the program shows its climate impacts including sea level rise and ocean pH level. The validity of C-ROADS program is shown in figure 4 matching real data and simulated result from C-ROADS.

3.2. World Climate-climate change negotiations game

The World Climate is a role-playing exercise of the UN climate change negotiations for groups. The purpose of the game is to gain insights, develop leadership, and diffuse into real-world action (Facilitator guide, 2016). The purpose matches with the goal of the environment education that Ministry of Education announced.

A facilitator takes the role of an UN leader, while each participant plays the role of a delegate representing a specific nation or region. Participants do their best to maximize the benefit of their own nation or region on one hand, but on the other hand, they should try to meet the

global goal that UN announces: well below 2˚C over preindustrial levels globally until the year of 2100(Climate Interactive).
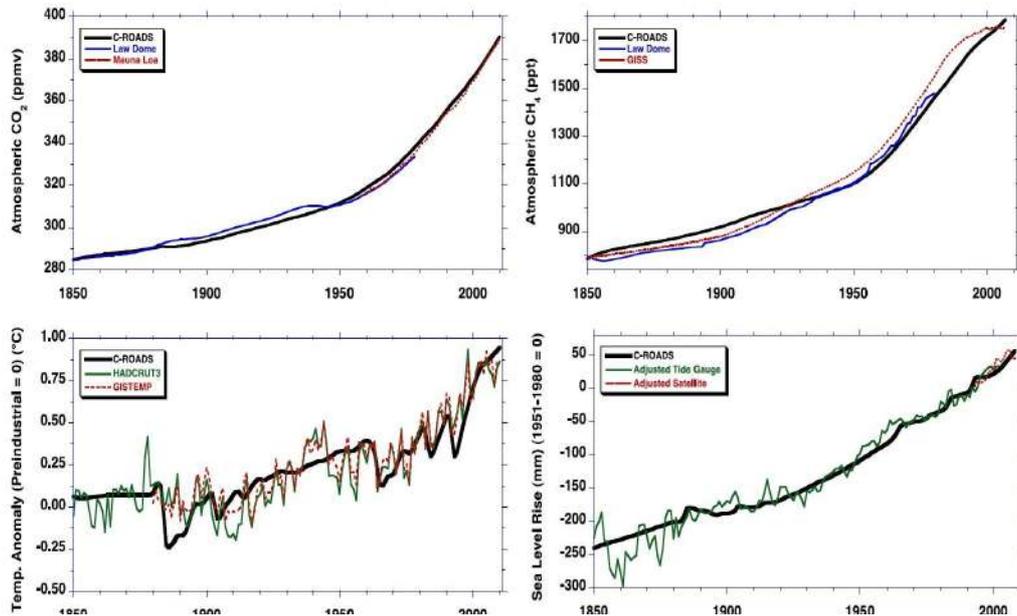

Figure 4. Real data compared to the C-ROADS output

Every participant reads confidential document that shows different interpretation and perspective according to the nation. Based on the documents and discussion within and between the nations, each delegate makes decisions to response climate change. C-ROADS then shows the overview and the consequence of those decisions. During the game, it is the performance of covering participants with big blue blanket pretending overwhelming sea wave resulted from global warming to gives a shock to all participants dramatically. On the debriefing session, each participant shares their feeling and promises to conserve the environment.

3.3. World Climate and Systems Thinking

Counter-intuitiveness of the system is the first lesson that participants learn through the game. Decisions to lessen greenhouse gas do not immediately lower the globe temperature nor sea level rise. That is like closing a bit of inflow faucet does not decrease the amount of the water in the bathtub. Delay feature observed in climate change is another lesson that participants could learn.

"Structure produces behavior" is the second lesson that participants

take away. Confidential document with different nuance and interpretation gives each participant a different frame to forge a different mental model. Participants with confidential document experience structural problems surrounding the climate change issue. This realistic and unique experience let participants think about their role as a global citizen.

5. Environment Education Curriculum Proposal using World Climate

5.1. Collaboration with local government

SBA or Seoul Business Agency[4] has tried to introduce various problem solving methodology for citizens to handle complex problem of Seoul, the one of the biggest megacity in the world. Dr. Chang Kwon Chung got the chance that systems thinking education could go public in 2014. Accumulation of small success of systems thinking education for citizens enables him to get the bigger chance when SBA tried to support Seoul Metropolitan Office of Education with decent fund and education programs of problem solving for 1st grade students of middle school in Seoul.

The possibility of systems thinking education in middle school in South Korea was proved by the K-12 SD education experience in 2015: 189 elementary school students in 7 classes of 6th grade and 712 middle school students in 27 classes of 1st grade.

5.2. GBR(Game Based Reflection) Model

Considering the original goal and the current limits of the environment education, systems thinking education with World Climate could work as a solution. Based on the success of systems thinking in K-12 education supported by SBA, we develop new curriculum of 8 weeks or 16 sessions, 2 hours each week or 1 hour each session with GBR(Game Based Reflection) Model.

Figure 5 illustrates frame of GBR model. First step is to play World climate-climate change negotiations game with which students can

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4) SBA is the affiliated institute of Seoul Metropolitan Government

get lesson of "Structure produces behavior" and the dangerous environmental changes that await us. This reflection can make students alert and involved like priming water for systems thinking.

Figure 5. GBR, Game Based Reflection, Model

Second step is to reinforce learning systems thinking with physical play and discussion. And third step is to analyze the structural problem making causal loop diagram in groups. Final step is to make an idea for new future job to divert business-as-usual structural behavior. The highlight of GBR model is the circular feature of steps. This model shows that even the final step can be the previous step of first step, which means repetition of same curriculum can make another result(causal loop diagram and new future job) and deeper reflection.

5.3. Details of curriculum

The key performance indicator of this program is causal thinking with causalities in causal loop diagram, circular thinking with feedback, and dynamic thinking with behavior over time graph.

The curriculum is divided into three phases: playing World Climate, learning basic principles of systems thinking with games and workshop, and applying it to environment and community issues.

Students would be exposed to the systems thinking by participating World Climate. As shown in the table 1, playing the game takes two weeks or 4 sessions including debriefing.

On the next phase, students learn basic principles of systems thinking. Beginning of the fifth session, students will learn and practice to distinguish between correlation and causality fostering logical thinking. In the following session, students will play the Connection Game. Each student experience the interconnection of the system doing physical activity (Quaden et al, 2008).

Circular thinking is developed in the first session of 4th week by the Connection Game. Students stand circle, pin two people in mind, and try to position themselves in the middle of two individuals. The game fosters circular thinking in that one affects others, and the others at the same affect the one. In the following second session of 4th week, students begin to learn to extract circular connection or feedback from complex interconnections. In the 5th week students begin to learn about archetypal structure starting with Unintended Consequences Archetype leading to workshop handling real-life examples.

The Mammoth Extinction Game is core of the 6th week. In this game students understand the change of extinct animals and ecosystem's change over time and more interestingly make stories from behavior over time graph of mammoth becoming extinct. At the end of this game, students are acquainted with feature of change, exponential growth and decay.

In the following 7th and 8th weeks, by reviewing and practicing several times, students would get familiar with the systems thinking and be able to come up with solution to environment and community issues which they face in daily life. This sequence of program perfectly meets the goal of the environment education that Ministry of Education declared: to analyze and solve the community environment issue. The summary of the curriculum is shown in Table 1.

K-12 SD education division of Korean Systems Dynamics Society led by professor Dr. Chang-Kwon Chung has already successfully tried the very curriculum in a Seoul National University Middle School in Seoul in 2016.

Table 1. Curriculum applied by systems thinking with World Climate

Week	Session	Topic	Contents	Activities
1	1	UN Climate Change Negotiation Game I	• Playing UN Climate Change Negotiation Game • Understanding the severity of climate change • Reflecting on delay effect	game, worksheet, discussion, presentation
	2			
2	3	UN Climate Change Negotiation Game II	• Playing Game (continued) • Sharing feelings after game • Reflecting on "Structure produces behavior." • Discussing solutions for climate change issues	
	4			
3	5	Hello! Systems thinking!	• Understanding the change I : <u>Causality</u> • Telling causality from correlation • The story of "The King's Weird Decision"	worksheet, discussion, presentation
	6	Workshop for community issue I	• Selecting community problem • Discussing causalities in <u>environment-related community problem</u> by group	
4	7	Connection Game	• Understanding the change II: <u>Feedback</u> • Understanding the interaction of complexity systems • Getting hands-on experience of interaction	play, worksheet, discussion, presentation
	8	Feedback Game		
5	9	Archetype Workshop I	• Understanding the change III: <u>Delay effect</u> • Understanding two type of feedback (R, B loop) and delay effect with ear digging case • Learning <u>Unintended Consequences Archetype</u>	worksheet, discussion, presentation
	10	Workshop for community issue II	• Discussing <u>Unintended Consequences Archetypal structure</u> from community issues	
6	11	The Mammoth Extinction Game	• Understanding change of extinct animals and ecosystem's change over time • Making story from time-based behavior	game, worksheet, discussion, presentation
	12		• Understanding the change IV: <u>Exponential Change</u> • Interpreting behavior over time with story	
7	13	Archetype Workshop II	• Learning <u>Shifting the Burden Archetype</u> • Elaborating various cases by group	worksheet, discussion, presentation
	14	Workshop for community issue III	• Discussing <u>Shifting the Burden Archetypal structure</u> from community issues	
8	15	Workshop for community issue IV	• Presenting the final structure analysis about community issues and policy proposal	worksheet, discussion, presentation
	16	Exploring future jobs	• Describing the future of unchecked-community's behavior • Suggesting new jobs to curve the doomed future.	

The sessions and hours were exactly followed by the curriculum above. Picture 1 is the sketch of the World Climate in the middle school. Picture 2 is the sketch of connection game in the seventh session. Picture 3 is the CLD related to pollution.

Majority of students were highly satisfied with this curriculum. The average of satisfaction survey result was 9.2 points (0 to 10 scale), or 58 percent NPS(Net Promoter Score).

Most of all comments from students after program echoed with environmental sensitivity, which the Ministry of Education ultimately aimed after. Some comments from students are shown below. Furthermore, one student even voluntarily films himself how he felt and learnt through World Climate (http://bit.ly/korea-k12-voice, Youtube clip of one participant).

"It was surprising to see unchanged amount of Carbon Dioxide emission, although both developed countries and China put a tremendous efforts. I have learnt more about the environment than reading the textbook."
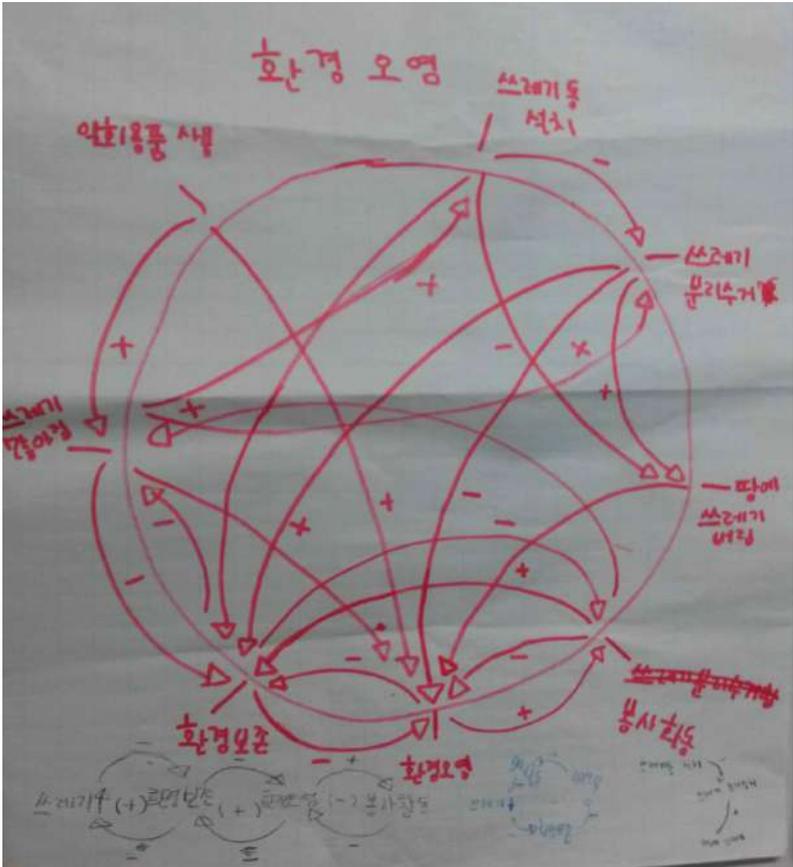
"Realistic than ever, it was amazing to see the unchanged sea level despite the reduction. The result was different than I have past learnt."

Picture 1. World Climate played in the middle school

Picture 2. Connection Game played in the middle school

Picture 3. A work in the middle of workshop for CLD

6. Conclusion

Demand for environment education emerged first in South Korea in 1992, because the government and society faced environmental issue. However, despite the strong beginning, the adoption rate for the environment subject has been declining due to the major problems in the current environment textbook: lack of holistic view and hands-on activity. This paper proposed a curriculum of systems thinking with World Climate: climate change negotiations game. The feasibility was approved by the successful case of the Seoul National University Middle School.

This case has illustrated that the original and ultimate goal of the environment education would be met through this very curriculum. Holistic view could be developed by systems thinking practice: causal, circular and dynamic thinking. Hands-on activity is successfully covered by World Climate: climate change negotiations game which students empirically enjoyed. Environmental sensitivity could be cultivated by the game and overall curriculum.

The official environmental education in South Korea is facing the implementation of the fifth amendment of which project started from 2015, and of which the textbook and the curriculum would be actually changed from 2018. So, spreading systems thinking with World Climate would largely benefit public education in South Korea influencing the amendment of textbook and, moreover, letting students learn the environment *by heart*.

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Climate Interactive www.climateinteractive.org

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OCP(Mohammed VI Polytechnic University www.ocpgroup.ma

Seoul Business Agency www.sba.or.kr

UMASS LOWELL Climate Change Initiative www.uml.edu/Research/Climate-Change