

Development and Implementation of a Student-Centered Climate Change Response Competence Program

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Abstract : The purpose of this study was to develop a climate change education program designed to foster climate change response competence, defined as a comprehensive capacity that includes how to cope with climate disasters as well as the knowledge, skills, and attitudes needed to prepare for a sustainable future, and to examine its effects. The program consisted of five learning modules: understanding climate change, surviving floods, escaping heatwaves, coping with cold waves, and an “Save the Earth” action module. To promote active, student-centered learning, the program incorporated a range of audiovisual materials and games to support engaging participation. When the program was implemented with elementary and secondary students, participants’ responses were overall positive. Students reported that the lessons were enjoyable and easy to understand. They also indicated that they learned how to act in climate-crisis situations and showed stronger intentions to take action to protect the environment. In addition, students perceived the program as beneficial and expressed a desire to take similar lessons in the future. This study is significant because it developed a concrete climate change response competence program spanning multiple grade levels and empirically examined participants’ responses.

Key Words : Climate change education, Climate change response competence, Climate hazards, Climate crisis, Student-centered learning

요약 : 이 연구의 목적은 기후 재난이 발생했을 때의 대처 방법, 지속가능한 미래를 대비하는 지식, 기능, 태도를 포함하는 총체적 역량으로 정의되는 기후변화 대응 역량을 함양하기 위한 기후변화교육 프로그램을 개발하고 그 효과를 검증하는 것이다. 개발한 학습모듈의 주제는 기후변화 이해하기, 홍수에서 살아남기, 폭염에서 탈출하기, 한파에서 벗어나기, 지구 구출大作전이었다. 학생들이 흥미롭게 학습에 참여할 수 있도록 다양한 시청각 자료, 게임 등을 포함하고 적극적 활동에 기반한 학습자 중심 학습이 가능하도록 설계하였다. 해당 프로그램을 초·중등 학생들에게 적용한 결과, 참여자들의 반응은 전반적으로 긍정적이었다. 학생들은 본 프로그램의 수업이 재미있고, 이해하기 쉬웠다는 반응을 보였다. 기후 위기 상황에서 어떻게 행동해야 할지 알게 되었고, 환경 보호를 위해 행동하려는 의지를 높이는 모습을 보였다. 나아가 본 프로그램 참여를 유익하게 생각했으며 이런 수업을 더 받고 싶다고 하였다. 이 연구는 다양한 학령을 아우르는 기후변화 대응 역량 프로그램을 개발하고 참여자의 반응을 실증적으로 조사했다는 점에서 의미가 있다.

주요어 : 기후변화교육, 기후변화 대응 역량, 기후 재난, 기후 위기, 학습자 중심 학습

I. Introduction

Climate change is among the most urgent and complex

“super wicked problems” of our time, exerting profound impacts not only on natural ecosystems but also on human societies and the global economy (Cross and

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Congreve, 2021). According to the World Meteorological Organization (2024), 2023 was the warmest year on record, and the global mean temperature rose to around 1.45°C above the pre-industrial baseline (1850-1900). The effects of climate change are already being felt in everyday life. Across many regions, unprecedented torrential rainfall and intense localized downpours, increasingly severe summer heat and tropical nights that repeatedly set new records, and sudden winter cold waves and heavy snowfall have contributed to unexpected climate-related disasters, resulting in economic losses as well as loss of life (Thunberg, 2023). More recently, in Blatten in Switzerland's canton of Valais, a glacier destabilized by global warming triggered a landslide, with ice, rock, and mud reportedly covering more than 90% of the village. In this way, climate change is amplifying risks in everyday life and calling for wide-ranging societal change.

Human activities, particularly the consumption of fossil fuels, are widely identified as the primary drivers of contemporary climate change. The scale of human influence on the Earth system has become so extensive that the notion of a new geological epoch, the Anthropocene, has been proposed (Crutzen, 2002; Waters *et al.*, 2016). The IPCC (2021) states that it is “unequivocal” that human influence has warmed the atmosphere, ocean, and land, and concludes that the observed warming is primarily due to anthropogenic increases in greenhouse gas concentrations. Given the growing magnitude of human influence on the climate, it is increasingly imperative to understand current conditions accurately, to make sound judgements for a sustainable future, and to take timely action. In particular, efforts to reduce climate risks require an integrated consideration of both mitigation, which addresses the causes of warming, and adaptation, which prepares societies to cope with impacts that are already occurring (Anderson, 2012; Stevenson *et al.*, 2017).

Education plays a pivotal role in raising awareness of climate change and strengthening public understanding of the issue (Monroe *et al.*, 2019; Hügel and Davies,

2024; Cashwell and McNeal, 2025). The OECD (2018), in presenting a concrete blueprint for reforming future education and cultivating students' competencies, identifies climate change as a shared challenge for humanity. Likewise, the IPCC (2023) emphasizes that education should play a central role in responding to the climate crisis, while UNESCO (2024) highlights the need for systematic programs to build capacities for climate action. Climate change education has therefore been framed as a foundational means of preparing students to respond to climate risks, and as a key strategy for promoting change not only in knowledge but also in attitudes and behaviors (Stevenson *et al.*, 2017; Aeschbach *et al.*, 2025; Thomas *et al.*, 2025).

In South Korea, there has also been growing attention to climate change education. The 2022 revised national curriculum has recently been announced, and it explicitly recognizes climate and ecological change as one of the major contextual drivers of curriculum reform, while positioning environmental education and education for sustainable development as cross-curricular themes (Ministry of Education, 2022). Accordingly, climate change-related content is incorporated across multiple subjects from primary through upper-secondary education. Notably, new electives explicitly focused on climate change, such as “Climate Change and Sustainable World” and “Climate Change and Environmental Ecology”, have been introduced. The fact that new subjects have been developed with climate change as a central organizing principle underscores the prominence of climate change within the Korean curriculum. Despite broad agreement on the importance and necessity of climate change education, however, there remains a shortage of concrete and effective programs in practice (Monroe *et al.*, 2019; Rousell and Cutter-Mackenzie-Knowles, 2020; Hong, 2024). There is therefore a need for programs that span the full range of school years and engage students through interest-provoking and participatory learning experiences in order to foster climate-related competencies. Indeed, this is a moment when everyone living on the planet must attend to

climate change and act without delay (Thunberg, 2023).

This study develops an educational program to enhance students' understanding of climate change and strengthen their climate change response competence, and evaluates its effectiveness. In this study, climate change response competence is conceptualized as an integrated set of knowledge, skills, and attitudes for preparing for a sustainable future, together with the capacity to respond appropriately to climate-related disasters. Accordingly, the article addresses the following research questions. First, how can a program designed to foster climate change response competence be structured? Second, how do participating students respond to the program?

II. Climate Change Education

Interest in climate change education has grown alongside the escalating impacts of climate change worldwide. As the IPCC (2021) asserts that it is unequivocal that human influence has warmed the climate system, climate change has become a pressing, real-world challenge that demands societal transformation. Attention to the extent of human influence has prompted the proposal of the Anthropocene as a new geological epoch, and related debates have expanded considerably across disciplines (Crutzen, 2002; Waters *et al.*, 2016; Wildcat and Schneider, 2025). Consequently, discussions of human activity and climate change have become among the most salient global issues of our time.

Against this backdrop, there is increasing interest in climate change education as a means of understanding the urgency of the current situation and developing the capacity to respond wisely in ways that support a sustainable future (Anderson, 2012; Rousell and Cutter-Mackenzie-Knowles, 2020; Thunberg, 2023). In this vein, Stevenson *et al.* (2017:68) emphasized the complexity of climate change and argued that, in preparing for an era characterized by uncertainty and unpredictability,

inquiry-based climate change education that centers students' investigation and interpretation of evidence is particularly important.

The very complexity of the problem and the uncertainty of ways of responding means that it is best addressed through curricular and pedagogies that fully allow students to explore the nature of the problem, discuss and debate appropriate pathways forward and take positive actions.

Bladh *et al.* (2018), drawing on Klafki's terminology, framed climate change as an epoch-typical key problem and argued that it should become part of the core content of school education. From a similar perspective, the UK's Geographical Association (2024) suggested that understanding climate change and sustainability, together with the development of green skills, should be central elements of the curriculum and assessment. Lambert *et al.* (2025) further noted that climate change can be positioned as a major focus in terms of developing powerful knowledge. This emphasis is significant in that a meaningful understanding of climate change requires a strong foundation in geographic concepts, and students need to be able to participate competently in related discussions across multiple scales.

Building on growing recognition of the importance and necessity of climate change education, research has increasingly focused on developing specific instructional strategies and examining their effectiveness. For instance, Thomas *et al.* (2025) proposed an approach that combines fieldwork with game construction. In their study, participants conducted fieldwork on the Isles of Scilly and then designed games focused on the climate crisis, drawing on the information collected and the experiences gained in situ. Through this creative integration of two participatory pedagogies, students were able to consolidate their climate change knowledge while strengthening key competencies such as critical thinking, creativity, collaboration, and communication. Cashwell and McNeal (2025) adopted a digital platform, *Climate Analysis and*

Visualization for the Assessment of Species Status (CAnVAS), into climate change education. By using the platform, students were supported to recognize the significance of climate change and were provided with opportunities to actively investigate how climate change affects threatened species. Rooney-Varga *et al.* (2025) reported the educational impacts of the *World Climate Simulation*, an interactive role-play and simulation platform. In their study, learners assumed leadership roles across different economic sectors and negotiated climate-related policies and courses of action, after which they explored the projected consequences of decisions through the simulation model. This approach aimed to move beyond knowledge transmission by linking evidence-informed decision-making with emotional engagement, behavioral intentions, and concrete actions. The findings indicated improvements in participants' climate knowledge and engagement, with effects persisting for at least six months. Complementing these individual examples, Monroe *et al.* (2019) synthesized effective strategies for climate change education through a meta-analysis. Their results suggested that effective approaches typically employ meaningful information that is personally relevant to learners and adopt learner-centered strategies that actively engage students. Monroe *et al.* further identified four strategies that are particularly useful when teaching controversial issues: facilitating deliberative discussion, enabling interaction with scientists and engagement in scientific processes, identifying and correcting misconceptions about climate change, and implementing community participation projects.

In the South Korean context, research on developing climate change education programs has also been expanding. For example, Hong (2024) reported that a community participation-based climate change program was effective in fostering practical competencies in responding to climate change. Participants engaged in a sequence of activities that included recognizing climate change problems, understanding carbon reduction, collaborating with local community experts, and carrying out climate response practices, which supported their

capability to understand climate change in real-world contexts and develop practical engagement capacities. Jeon and Kim (2024) extracted climate change-related content through an analysis of the elementary school curriculum and developed AI-enabled climate and environmental education programs that were tailored to learners' developmental levels. Jeon and Kim offered insights by providing practical ideas for integrating a range of AI technologies into climate change education. Moon and Kim (2025), drawing on a more-than-human geographies perspective, further highlighted the potential of climate change education to cultivate empathy beyond human-centered thinking by attending to the agency and interactions of diverse agents, and suggested that such empathy may serve as a driver for a sustainable future and climate justice.

As such, the importance of climate change education is increasingly recognized and the related research base continues to expand. However, there remains a substantial demand for concrete and effective teaching and learning strategies for climate change education (Stevenson *et al.*, 2017; Monroe *et al.*, 2019; Rousell and Cutter-Mackenzie-Knowles, 2020). Anderson (2012) argued that education has not yet been fully leveraged as part of climate change responses, highlighting the need for systematic support to strengthen teachers' professional development in this area. Healy *et al.* (in press) similarly reported that, although many teachers attempted to introduce climate change into the curriculum, the lack of structured support means that practice often relies on a largely "self-taught" approach. Furthermore, curriculum making has tended to occur primarily at the classroom level (the nano site) or the school level (the micro site), rather than being supported more systematically across wider scales (Rushton and Walshe, 2025). At a time when the climate crisis is intensifying, sustained attention to diverse and actionable pedagogical strategies is urgently needed to enable meaningful climate change education.

III. Development of the Climate Change Response Competence Program (CCRCP)

1. Program aim

The CCRCP aims to strengthen learners' climate change response competence through student activity-centered education (Figure 1). In this study, climate change response competence encompasses the knowledge, skills, and attitudes needed to prepare for a sustainable future, as well as the capacity to respond appropriately when climate-related disasters occur. This competence encompasses an informed understanding of the broader climate challenge, the capacity to respond to climate-related risks in everyday life, and dispositions that support sustainability-oriented action. This conceptualization is informed by arguments that effective climate change education should address multiple competencies and integrate both mitigation and adaptation (Stevenson *et al.*, 2017). For example, Tang (2022), in proposing a model of behavioral climate change education, argued that climate education must extend beyond know-

ledge to include practical and community engagement dimensions to narrow the gap between attitudes and behaviors. Rooney-Varga *et al.* (2025) similarly focused on whether climate change knowledge translates into concrete action. Taken together, these perspectives underpin the design of the CCRCP, which aims to foster climate change response competence as an integrated set of knowledge, skills, and attitudes.

2. Program design principle

The CCRCP was designed to enable learners to acquire climate change knowledge, practice relevant skills, and develop desirable attitudes towards a sustainable world through a range of climate-related learning activities. Each learning module includes an introduction to key concepts related to the module theme as well as activities in which students apply and rehearse a variety of skills. In this process, students are encouraged to reflect on sustainability-related values and to develop constructive attitudes towards a sustainable world. To enhance interest in the program and promote active participation, the modules were designed around student-

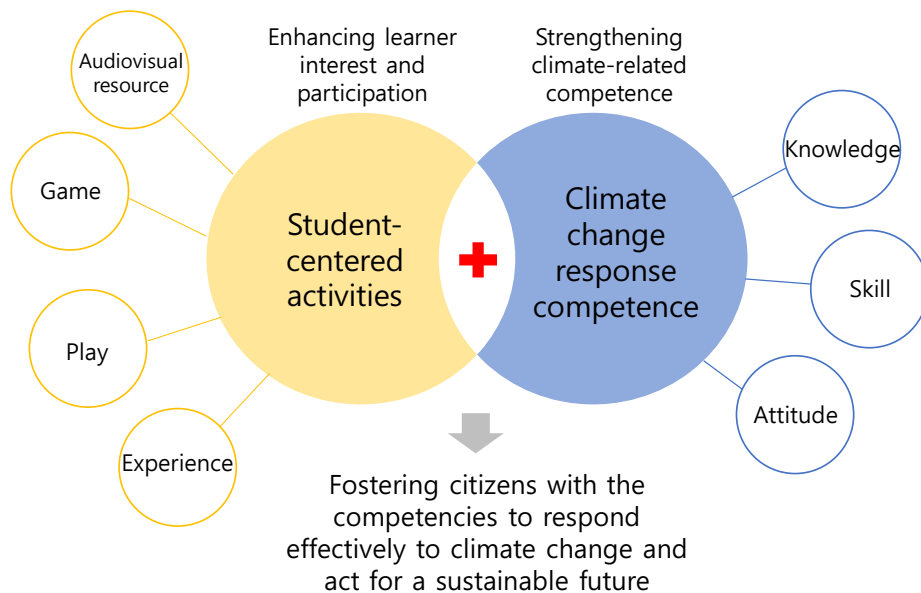


Fig. 1. The CCRCP framework

centered activities. More specifically, the program was developed according to the following design principles.

First, modules are designed to reflect a coherent progression from awareness to preparedness to action, enabling students to recognize climate change-related situations, prepare for specific hazards, and take action for a sustainable environment. Within the preparedness dimension, content focuses on floods, heatwaves, and cold waves, which students are likely to encounter directly or indirectly in everyday life.

Second, each module includes at least one audiovisual resource. By drawing on audiovisual materials related to the learning topic, the modules aim to stimulate interest among students who are accustomed to video-based media and to support them in understanding the topic within real-world contexts (Kay, 2012; Nunohara *et al.*, 2020).

Third, each module includes at least one game or play-based activity. As part of a learner-centered approach, learning games and play are used to encourage students to participate actively while experiencing learning as enjoyable. Games constitute a meaningful part of young people's culture (Green and McNeese, 2007), and a range of studies has reported the educational benefits of games and play (Karakoç *et al.*, 2022).

Fourth, each module incorporates worksheets to ensure that activities serve not merely to generate interest but to lead to substantive learning. In addition, the modules were structured so that teachers can adjust both the number and the level of activities in accordance with students' needs and available lesson time. To support such flexibility, the program provides explicit guidance on how activities can be selected or adapted depending on time constraints and differentiated by year group.

3. Program validation procedures

The validity of the CCRCP was strengthened through multiple procedures. First, during the development phase, an initial draft was developed through an extensive review of literature on climate change and climate

change education. Through this process, key content areas were clarified, including the causes and current status of climate change and the major types of climate-related disasters. In addition, a range of learner-centered instructional strategies was examined and used as a foundation for designing effective learning modules. This rigorous development process provided an essential basis for establishing the program's validity.

Second, the draft program was piloted with seven teachers and two graduate students specializing in geography education. Participants engaged in the activities as learners and provided feedback on whether the sequence of learning activities was coherent and engaging, whether any practical difficulties arose during implementation, and how the presentation of concepts and activity formats might be improved. The program was then revised in response to this feedback to enhance its validity.

Third, the revised program was implemented with 23 instructors who would subsequently deliver the CCRCP to students. The program was developed for large-scale implementation across schools throughout South Korea; accordingly, a sizeable pool of trained instructors was required. This stage therefore served a dual purpose: it supported instructors' understanding of the program and strengthened their capacity to deliver it, while also allowing the identification of strengths and limitations of the modules from practitioners' perspectives. The instructors, many of whom had extensive experience teaching students, drew on their professional knowledge of classroom practice to anticipate potential challenges and offer concrete suggestions for improvement. The final version of the program was confirmed after incorporating this feedback.

IV. The Content of the CCRCP

1. Overview

The program developed in this study comprises three

dimensions and five modules and is organized around a coherent logic of awareness, preparedness, and action (Table 1). The awareness dimension serves as an introduction, focusing on recognizing the drivers of climate change and the problems it generates. The preparedness dimension then addresses three climate-related hazards, flooding, extreme heat, and cold waves, and supports learning about how to anticipate and manage risks associated with these events. The action dimension invites students to explore ways of addressing climate change and to consider practical actions they can take to contribute to a more sustainable future.

Engaging with all five modules enables the program's aims to be addressed most comprehensively. At the same time, however, the modules were designed to be sufficiently self-contained to allow flexible implementation across different instructional contexts. For example, selecting one module from each dimension offers a shortened route through the overall program logic (awareness module 1, preparedness module 1, and action

module 1). Alternatively, focusing on the preparedness modules (flooding, extreme heat, and cold waves) may be particularly useful for strengthening learners' ability to anticipate and manage climate-related hazards that have substantial impacts on everyday life. If the instructional emphasis is less on general awareness and more on practical preparation and action, one preparedness module can be combined with one action module. Finally, engaging with a single module can still constitute a meaningful learning experience in its own right. Overall, the program was designed to enable meaningful climate change learning through selective combinations of modules that can be tailored to local needs and constraints.

2. Detailed module content

The learning modules developed in this study provide instructional materials, including a lesson plan, Power-Point slides, and worksheets. All modules also incorporate

Table 1. Structure of the CCRCP

Dimension	Module	Learning objective
Awareness	Climate Detective: Understanding climate change	• Identify climate change-related phenomena occurring in different parts of the world. • Locate, on a map, regions where extreme or abnormal weather events are occurring. • Recognize climate change and environmental problems and develop an empathic stance by considering impacts from the perspective of those affected.
Preparedness	Mission Possible: Surviving floods	• Explain the meaning of flooding, describe flood impacts, and articulate why floods pose risks. • Understand how to respond during floods and select appropriate actions depending on the situation. • Recognize various risk situations that may arise during floods and respond appropriately.
	Cool Down Together: Escaping heatwaves	• Define heatwaves and explain the relationship between climate change and heatwaves. • Identify personal and societal strategies for responding to heatwaves. • Recognize ways to respond to heatwaves and apply them to real-life situations.
	Warm Up Challenge: Coping with cold waves	• Understand the meaning of cold waves as a natural environmental factor that affect human health and everyday life. • Explain key characteristics and impacts of cold waves. • Apply appropriate strategies to respond to cold waves in real-life situations.
Action	A Call to Action: Save the Earth initiative	• Explain key causes of environmental problems and identify feasible actions to contribute to addressing them. • Foster willingness and confidence to engage in climate-related action in everyday and community contexts.

topic-related videos and a game-based activity. Further details of the modules are provided below.

First, the *Climate Detective* module begins with a sound-matching activity that invites students to anticipate a range of climate-related phenomena addressed in the program. The activity draws on sounds that directly represent climate-related hazards (for example, the sound of heavy rainfall), as well as more playful prompts designed to spark curiosity, such as inferring a cold wave from the sound of a zip being pulled up, and a video of Greta Thunberg's speech, which encourages students to reflect on the meaning and urgency of climate change. Students then examine real-world scenes of climate disasters to understand the climate hazard under discussion and locate the affected regions on a map. This activity presents a narrated scenario of a climate-disaster situation using an AI-generated voice (for example, a koala requesting help after losing its habitat to wildfire) and is designed to support learning about how climate change is affecting that region. Finally, students create empathy maps from the per-

spectives of various actors experiencing climate disasters, enabling them to engage more deeply and imaginatively with the climate crisis unfolding across different parts of the world. Figure 2 shows an activity conducted before completing the empathy map, in which students consider the climate crisis from the perspective of the local residents they have learned about.

Second, the *Mission Possible* module focuses on building disaster preparedness by engaging students in a “survival backpack” activity, in which they select essential items to pack under constrained conditions during a flood. Learners use a game-based format to test whether the items they chose are appropriate for the specific flood scenario. The task is designed to be engaging by requiring students to make decisions about what is truly necessary in urgent, resource-limited circumstances (Figure 3).

Third, in the *Cool Down Together* module, students first identify heatwave preparedness strategies in multiple contexts by sorting climate cards that present a range of personal and societal actions for dealing with extreme

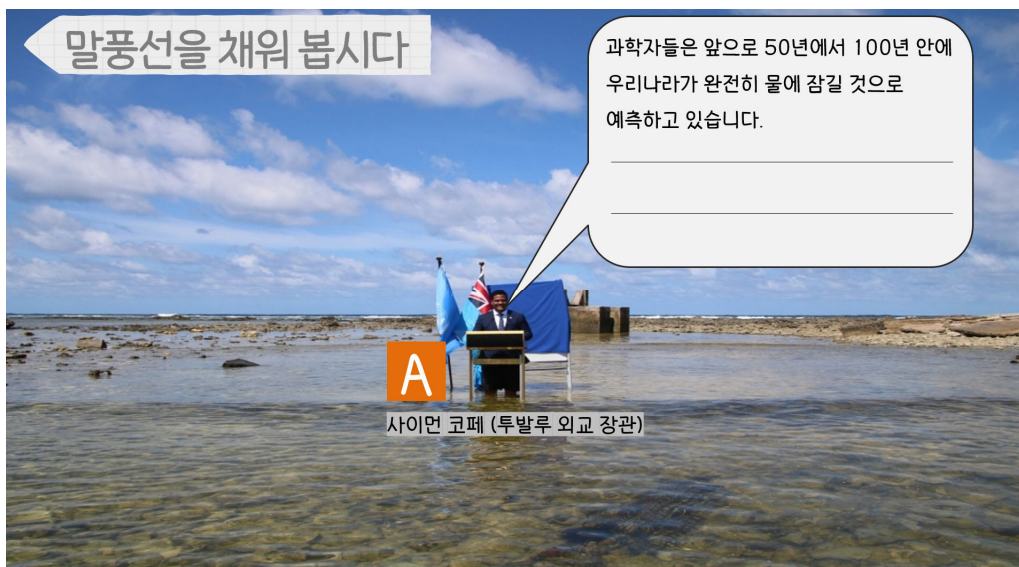


Fig. 2. Empathizing from the perspective of Tuvalu residents

* Through this activity, students consider climate change from the perspective of Tuvalu residents whose country is at risk of being inundated by rising sea levels. By engaging with the perspectives of people directly affected by climate change, the activity helps students relate climate change to their own lives and develop an empathetic understanding of its real-world impacts (Photo source: Ministry of Justice, Communication and Foreign Affairs, Tuvalu Government official Facebook page).

heat. Next, participants combine heatwave scenario cards to create narratives. To encourage creative story-building, the card set includes cards depicting heatwave-related situations alongside one unrelated card, prompting

students to construct a creative yet plausible narrative (Figure 4). Finally, drawing on what they have learned through the previous activities, students internalize preparedness strategies through a fast-paced game in



Fig. 3. Packing a survival backpack

* In this activity, students select items needed during a flood, taking account of constraints such as weight and size, and place them in a “survival backpack” using stickers. Scores are then awarded depending on whether the student’s backpack contains items required in a range of scenarios. For example, if it becomes very dark during evacuation, having a torch or headlamp in the backpack results in additional points, whereas not having one leads to a deduction.



Fig. 4. Creating a heatwave narrative

* This activity asks students to create a narrative about a day in an overheated city affected by intense heat. A set of cards is presented one by one, and students develop the story in response to each card as it appears. The cards include heatwave-related strategies, such as applying sunscreen, providing cooling-cost support for vulnerable groups, and creating water-play areas alongside one card that is not directly related to heatwaves (for example, “protect your head under a table”). Within a limited time, students are expected to construct a narrative that is both meaningful and creatively plausible.

which they must quickly identify appropriate responses to heatwave scenarios.

Fourth, in the *Warm Up Challenge* module, students learn key concepts related to cold-wave preparedness through quizzes and games. They examine climatological factors associated with the occurrence of cold waves and engage with a range of scenarios that may arise when a cold wave occurs. A particularly distinctive activity in this module is a “guess the lyrics” game. The program developed a song and lyrics related to cold waves and designed activities that use these materials in multiple ways. For example, students first listen once to the full song (or to the target section) and attempt to write down the lyrics. Because the lyrics are unfamiliar, most students are unable to capture them in full. The teacher then provides successive hints, for instance, by replaying short segments rapidly or indicating the number of letters in a line, while students continue to refine their transcription (Figure 5). Through this process, students listen repeatedly and attentively to lyrics that embed the target concepts, enabling learning to occur in a natural and engaging way.

Fifth, the *A Call to Action* module aims to build knowledge and commitment for pro-environmental action. Students first locate four passcodes needed to open a “treasure box” by completing climate-related learning tasks. For example, they identify the carbon footprint of everyday foods and calculate a numerical value based on that information (Figure 6). The final passcode is 0605, referring to World Environment Day, to further reinforce environmental awareness. Students then draw climate action cards: if they draw a card that intensifies climate change, they remove one block from a tower built of stacked blocks; if they draw a card that supports climate action, they do not remove a block. A polar bear figure is placed on top of the block tower, so repeatedly drawing “intensifying” cards makes the tower unstable and increases the risk to the bear. This activity is intended to illustrate how behaviors that exacerbate climate change can threaten the survival of Arctic wildlife. Finally, students conclude the module by writing down actions they intend to take to address climate change.



Fig. 5. Lyric-guessing hints

* This module screen appears after students have listened to the full song and are given a spacing (word-break) hint. By checking the number of words or characters in parts they could not clearly identify while writing the lyrics in the previous step, students can refine their guesses and continue progressing with the lyric-writing activity.



Fig. 6. Calculating a carbon footprint

* In this activity, students calculate the carbon footprint of commonly consumed foods in order to identify a passcode. They access an online carbon footprint calculator, find the carbon footprint values for specific foods, and substitute these values into a given formula to complete the calculation and determine the passcode.

V. Implementation of the CCRCP

1. Participants and context

The CCRCP was implemented with a total of 2,722 students in South Korea. Participants comprised 1,580 primary school students (58%), 911 middle school students (33%), and 231 high school students (8%). Schools were recruited through an official circular distributed via regional offices of education, which provided information about the program. As this was the first year of implementation, the program was run in a pilot form. Accordingly, each school was permitted to

select only two of the five modules. Demand exceeded expectations, and registration closed shortly after the announcement. Implementation took place between June and November 2025. The first day of delivery was intentionally scheduled for 5 June, World Environment Day. The program was delivered on-site at participating schools by trained instructors (Figure 7).

2. Participants' responses

To examine participants' responses to the program, a post-program survey was administered after implementation. The questionnaire comprised five items, and

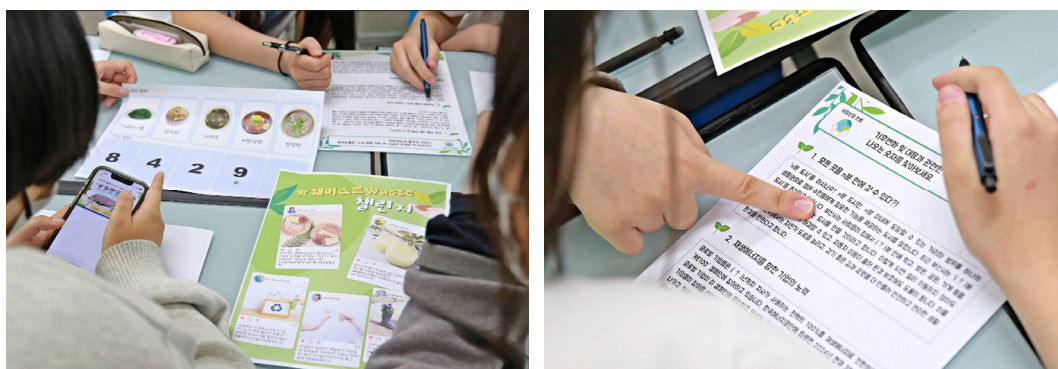


Fig. 7. Selected scenes from CCRCP implementation

students indicated their views on program participation using a five-point Likert scale. The survey items asked about students' interest, understanding, intentions to act, and willingness to participate in similar lessons in the future. As such, the questionnaire includes test items commonly used to evaluate the effectiveness of educational programs and therefore have acceptable validity (Kim, 2023).

Overall, participants' responses were positive (Table 2). The mean score for every item exceeded 4.0, suggesting that students perceived their participation in the CCRCP as a meaningful learning experience. A closer look at item-level responses indicates several noteworthy patterns. First, students reported that the lessons were interesting and easy to understand. Because learners' interest and comprehension provide a foundation for program effectiveness, these responses are promising. Interest in learning significantly predicts learning motivation (Herpratiwi and Tohir, 2022), and interest is positively associated with academic achievement (Primastami and Insani, 2024; Kehle and Urhahne, in press). From this perspective, it is plausible that students' enjoyable engagement in activities supported effective learning of climate change-related content. It is also likely that the program's design, calibrated to learners' levels, helped students understand the content more easily.

Second, students reported that the program helped clarify how to respond in climate-crisis situations and

strengthened their intentions to apply what they learned in practice. Ultimately, the behavioral dimension is central in climate change education programs (Jensen and Schnack, 1997; Kim, 2019; Torsdottir *et al.*, 2024). This underscores the importance of knowing how to respond in climate-crisis situations and of acting wisely to protect the environment in pursuit of a sustainable future. In this vein, research highlights behavioral climate change education that seeks to bridge the gap between climate knowledge and pro-environmental behavior by combining knowledge with practical skills and community engagement activities (Kolenatý *et al.*, 2022; Tang, 2022). Consistent with this perspective, participants' positive responses regarding action-oriented knowledge and intentions suggest that the CCRCP made a meaningful educational contribution.

Finally, participants indicated that the program was beneficial and that they would like to take similar lessons in the future. For the effects of climate change programs to be sustained, continued exposure to related learning opportunities, rather than one-off instruction, is important (Burkholder *et al.*, 2017; Reid, 2019). Longitudinal research suggests that when climate change education is provided continuously and repeatedly across subjects and lessons, climate literacy improves significantly and a substantial proportion of this effect is maintained over several years (Burkholder *et al.*, 2017). Accordingly, students' willingness to participate in similar

Table 2. Participants' responses to the CCRCP

Item	1	2	3	4	5	Mean
Today's lesson was interesting.	132 (5%)	128 (5%)	449 (16%)	628 (23%)	1,385 (51%)	4.1
Today's lesson was easy to understand.	66 (2%)	61 (2%)	357 (13%)	639 (23%)	1,599 (59%)	4.3
After the lesson, I learned how I should act in a climate crisis situation.	75 (3%)	78 (3%)	378 (14%)	622 (23%)	1,569 (58%)	4.3
After the lesson, I will put what I learned into practice to protect the environment.	89 (3%)	80 (3%)	445 (16%)	655 (24%)	1,453 (53%)	4.2
I found today's climate change education beneficial and would like to take similar lesson again in the future.	145 (5%)	144 (5%)	493 (18%)	508 (19%)	1,432 (53%)	4.1

* Note: 1 = strongly disagree to 5 = strongly agree

lessons again is meaningful in that it indicates the program's potential to serve as a catalyst for more sustained climate change education.

VI. Conclusion

The purpose of this study was to develop an educational program designed to foster climate change response competence and to examine its effects. Climate change response competence was defined as an integrated set of knowledge, skills, and attitudes for preparing for a sustainable future, together with the capacity to respond appropriately to climate-related disasters. Each learning module included an introduction to key concepts related to the module theme and a range of skill-application activities. As students engaged with concepts and practiced relevant skills, the modules were designed to support the development of sustainability-related values and desirable attitudes. The program comprised three dimensions, awareness, preparedness, and action, and included five modules mapped onto these dimensions. The awareness dimension focused on understanding climate change; the preparedness dimension comprised modules on floods, heatwaves, and cold waves; and the action dimension culminated in a module on taking action to protect the Earth.

The program was implemented across primary and secondary schools in South Korea between June and November 2025. Delivery took place at participating schools, led by trained instructors. Overall, students' responses to the program were positive. Participants reported that the lessons were interesting and easy to understand. They also indicated that the program helped clarify how to respond in climate-crisis situations and strengthened their intentions to act to protect the environment. Finally, students perceived participation as beneficial and expressed a desire to take similar lessons in the future.

This study is meaningful in that it developed and evaluated a concrete program for fostering climate

change response competence across multiple school levels. It conceptualized climate change response competence as an integrated construct comprising knowledge, skills, and attitudes, and translated this construct into specific program aims and learning activities, enabling a clearer discussion of educational outcomes. In particular, this study offers an innovative module design that builds climate change response competence across awareness, preparedness, and action, while specifying floods, heatwaves, and cold waves as focal hazards within the preparedness dimension. Although public interest in and educational demand for concrete climate change education programs continue to grow, relatively few studies have examined these issues empirically within the context of geography education. In this respect, the present study makes an important contribution. Moreover, the program was implemented with a relatively large student sample, providing empirical evidence of its educational value. This, in turn, supports future adaptation and scaling of the CCRCP across diverse contexts.

However, this study is limited by assessing student responses solely through post-program self-reports. Therefore, follow-up research is needed to assess the development of climate change response competence using a wider range of approaches. Systematic evaluation using multiple methods, such as interviews and analyses of students' work products, will be essential for quality assurance and for guiding program refinement. In addition, efforts to examine learners' changes more comprehensively through pre- and post-assessments are also needed.

Following the pilot year reported here, the program will be implemented on an ongoing basis. The modules will be adapted to changing contexts and needs, with the longer-term aim of establishing a sustainable program infrastructure. To maximize the program's reach and impact, continued efforts will be needed to develop a supportive implementation ecosystem. Planned follow-up work includes teacher professional learning initiatives to disseminate the program and build capacity for

effective delivery. Future work will focus on strengthening partnerships with local communities and systematizing the program so that it can be flexibly adapted to different local contexts. It is expected that this study will encourage additional program-focused research in South Korea, particularly research that develops and evaluates concrete climate change education interventions.

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