THE INFLUENCE OF A PROJECT-BASED CLUB PROGRAM ON MIDDLE SCHOOL STUDENTS' ACTION COMPETENCY IN RESPONDING TO CLIMATE CHANGE

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Abstract

Incorporating climate change into education is critical for building a sustainable future and empowering the next generation to take action. This study aims to explore how a project-based club program influences middle school students' action competency in responding to climate change. For this aim, ten students who participated in a project-based club program in a boys' middle school were selected. A pre-test on relevant knowledge was surveyed, students' behaviors during the program were observed, and in-depth interviews were conducted after the program. The results revealed that students showed a better understanding of climate change and carbon neutrality concepts, increased sensitivities to climate change, deepened reflections on climate change activities, improved communication and decision-making abilities, and improved willingness to take action in climate change mitigation activities. It was concluded that the project-based club program has positively influenced students' action competency in responding to climate change.

Keywords: *action competency, climate change, middle school students, project-based club program*

Introduction

Climate change has been recognized as a significant social problem worldwide and now emerged as a newly rising social problem in our lives closely related to local communities. Climate change is no longer a problem that only happens in other countries. To solve such a climate change problem, the international community is responding by organizing the Intergovernmental Council on Climate Change (IPCC). The IPCC recommended that carbon neutrality (net-zero), in which the amount of greenhouse gases

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caused by human activities is reduced to zero through carbon dioxide emissions and absorption, should be achieved in order to prevent ecosystem destruction and respond to the crisis facing humanity (IPCC, 2022).

Korea also actively responds to climate change issues by announcing the Korean version of the Green New Deal policy. This newly developed policy declared carbon neutrality by 2050 and established a presidential carbon neutrality committee for the greenhouse gas reduction goals (Kim, 2021). In the field of education, in order to better prepare for future uncertainties such as the climate crisis, climate change education in schools becomes strengthened with the goal of cultivating competencies necessary for the future society (Ministry of Education, 2022).

Students are going to be the most significant stakeholder in climate change of future society. They will take the role of a main agent of problem-solving and become a citizen of decision-making and a leader of society in the future, for future generations to deal with the climate crisis, climate change education needs to be strengthened. It is necessary to involve youth in efforts to solve problems such as climate change (Stephens & Ballard, 2021). It is an important task of the education system to ensure that young people are learning the right facts about the causes, societal impacts, and potential solutions of climate change, and to promote critical and ethical views on this complex issue (Kronlid, 2009; Ojala, 2012; Shin, 2023).

For this reason, students need to learn at school about how to participate in social problems and how to prepare for their roles. Recently, climate change education has stressed developing students' practical capabilities in daily life so that they can deal properly with climate change (Busch et al., 2019; Vaughter, 2016). Due to the urgency of climate change issues, climate change education emphasizes the importance of action competency in everyday life and opportunities for participation so that young people can play a promising role as ecological citizens.

Action competency refers to taking action voluntarily for solving problems and having competency as democratic citizens (Jensen & Schnack, 1997). In other words, action competency means the ability to act in order to solve issues and to become active citizens in a democratic society (Sass et al., 2020). Since action competency has been introduced in the field of environmental and sustainable development education, how to effectively develop students' action competency should have been more importantly recognized in schools (Baek et al., 2021).

In fact, environmental education has been implemented in schools for several decades in Korea. However, the school curriculum has not allocated a reasonable amount for climate change-related content, and its achievement standard remains at the level of knowledge acquisition and not focusing on action competency (Shin, 2017; Shin, 2023). On the other side, there have been relatively few studies conducted on the development of action competency (Baek et al., 2021). Even further, effective teaching methods to develop action competency in climate change have not been specifically introduced and examined.

The project-based learning can be considered as an effective educational method to develop students' action competency in climate change. It is well acknowledged that climate change is not just a scientific phenomenon but also involves a complex socio-scientific issue. It is necessary for climate change education that students are encouraged to find complex and uncertain problems occurring in the real world, define what the

problem is, understand the problem from the perspective of various interest groups, seek solutions based on cause analysis, and find the optimal solution (Blumenfeld et al., 1991; Lee & Hwang, 2019). In this context, project-based learning seems to be suitable for climate change education as it includes a variety of complex activities, such as finding a solution and finding possible alternatives to act (Jonassen, 1997). However, research on how the project-based club program influences on developing students' capability to deal with climate change, has not been conducted extensively in Korea.

Research Problem

The study paid considerable attention to the project-based club program about climate change. The school club programs are part of the creative experiential activities to help students perform practical and voluntary activities, cultivate a healthy mind and body, and develop their abilities of inquiry and problem-solving (Ministry of Education, 2015). The realization of action competency on global issues of climate change can be accessed through the project-based club program. In this study, a project-based club program is developed and applied to middle school students with the goal of cultivating action competency to deal with climate change as being ecological citizenship. Therefore, the research question in this study includes what kind of changes in middle school students' action competency related to climate change occurred after participation in the project-based club program.

Research Methodology

General Background

The aim of this study was to explore how the project-based club program influenced middle school students' action competency related to climate change. To accomplish the aim, a qualitative research design was chosen in taking advantages to reveal students' changes in depth from various aspects. This study was conducted with ten students who participated in a climate change club program at a boys' middle school located in a city with about 30,000 people. The city seems to be characterized by facing unfavorable circumstances of the deepened educational gap between urban and rural areas, poor rural economy, population decline due to low birth rate and intensified decrease in the number of incoming new students. In order to solve these problems, various strategies such as the school's development of a specialized curriculum suitable for local communities are required. In addition, as there are many students from broken families such as single fathers, single mothers, and grandparents' families, scholarship benefits and administrative and financial resources are needed foremost.

Sample

The students in the study participated voluntarily in a climate change club named 'NT2050 Green Center' on the theme of climate change education, ecological transformation education and civic education. These students showed high interest and preference in hands-on activities such as field trips, experiments, and practical training,

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as well as science, arts and physical education subjects. The participants in this club were ten male students, and the data collection was conducted with them under the students' and their parents' agreements at the beginning. The ten students consisted of two 7th graders, four 8th graders and four 9th graders.

Development of the Project-Based Club Program of Climate Change

Teacher K, who voluntarily took charge of the climate change club, was an English teacher with six years of teaching experience and has implemented several STEAM projects for various subject matters. The topic of climate change was kind of new to Teacher K. Teacher K studied about climate change on his own to provide students with various experiences. In fact, Teacher K was running a carbon-neutral challenge program for the whole school. Teacher K discussed about the contents and teaching methods for the club with the researcher in advance. The program was developed with STEAM contents by adopting the PDIE (Preparation-Development-Implementation-Evaluation) model (Kim, 2012; see Table 1). After the development of the project-based club program, the team of the researcher and Teacher K reviewed it thoroughly and revised it when needed.

The project-based club program was developed as a creative experiential activity program centered on carbon neutrality to cultivate middle school students' action competency. In particular, the program was developed with an emphasis on practical actions to change individual behaviors in order to develop action competency related to climate change and ecological citizenship. Through this program, first, participating middle school students are able to find examples of practical uses in real life and develop action competency in climate change in daily lives. Second, the students are able to integrate knowledge from various subject matters such as social studies, Korean language, and English as well as science into the program. Third, the program will allow students to participate in activities on their own initiative and to develop action competency to deal with climate change and ecological citizenship through cooperation with members.

Table 1

Procedures to Develop the Project-Based Club Program by Adopting the PDIE Model

Phase		Procedures	Contents
Preparation	1	Needs assessment	– literature review
	2	Analyze STEAM curriculum	– analyze 2015 and 2022 revised curricula
	3	Select learning standard	– problem contexts, creative design, emotional experiences
	4	Select integrated topic	– topic-centered, integrated with two or more subjects
Development	5	Select activity topics	– climate change (carbon neutrality)
	6	Set learning objectives	– action competency to deal with climate change
	7	Clarify performance expectation	– varied strategies to improve students' action competency
	8	Set contents of the topics	– ACT NOW! Campaign, choose one rule to follow daily carbon neutrality, the definition of climate change, and more
	9	Organize contents	– Introduction - Development - Summary
	10	Select STEAM contents	– NT2050 Green Center ACT NOW!
Implementation	11	Implement the STEAM program	– Implement a total of 8 class periods
Evaluation	12	Evaluate the STEAM program	– Administer tests and in-depth interview
	13	Revise and finalize the program	– Revise and improve the program

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Table 2
Overview of the Project-Based Club Program in Climate Change to Develop Action Competency

Step		Topics	Activities of Teaching and Learning
Introduction to Problem Contexts	1	Understand climate change	– Discuss examples of climate change experienced near – Changes in suitable areas for apple cultivation – Examine concepts and causes of climate change
	2	Understand carbon neutrality	– Investigate NET ZERO carbon neutrality – Do the board game of carbon footprint, – Share opinions about carbon neutrality
Creative Design	3	Global efforts on climate change	– Investigate global efforts on climate change – Share opinions about individual efforts on climate change – Make a picket to promote actions to deal with climate change
	4	Individual efforts and actions on climate change	– Introduce ACT NOW! by UN – Interpret 10 living rules in English into Korean – Each student selects one rule out of 10 living rules – Plan how to act accordingly, and take into action
	5	Practice ACT NOW!	– ACT NOW! Among the rules, practice SPEAK UP! – Explain climate change and picket at the Apple Festival – Summarize results of participation in the Apple Festival
Emotional Experiences	6	Find ACT NOW from neighborhood	– Understand the elements of producing a newspaper in English – Introduce a project to make ECO-TIMES newspaper in English – Group as teams to play different roles
	7	The ACT NOW what I found	– Present and share what each team developed – Design the layout of articles and photos – Produce articles in English
	8	Produce ECO-TIMES	– Finalize and present the ECO-TIMES newspapers – Publicize the newspapers within and out of schools via SNS – Write the report about the program

The project-based club program consists of three steps (see Table 2). The first step is about introduction to the contextual background of problem situations and the causes and effects of climate change are presented with two lesson themes. The second step is about creative design to explore climate change problem situations. In the second step, three themes are presented. The third step includes the development of action plans to implement solutions. It is structured so that people can plan and participate in social practices to deal with climate change issues through emotional experiences.

This project-based club program maintains the overall framework according to teaching and learning directions for the school club programs recommended by the Ministry of Education (2022) but allows students to choose on the operation and direction of detailed activities.

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Data Collection and Analysis

Data were collected in three ways. First, Teacher K administered the pre and post-tests about students' understanding of knowledge of climate change. The data provided changes before and after the program. Second, Teacher K took the observation journal during the program. Teacher K observed each student's distinct behaviors, participation, and interaction among peers and recorded them in the observation journal. Through the observation journal, individual students' thoughts and conceptual changes for each class activity were examined, and how and how much they contributed to the production of activity outputs were confirmed.

After all activities were completed, the researcher conducted in-depth interviews with participants about climate change focusing on seven perspectives, 1) climate change-related issues, 2) timeliness of climate change, 3) ability to reflect, 4) integrated thinking, 5) communication ability, 6) decision-making ability, and 7) willingness to take into action. In-depth interviews were conducted about 20-30 minutes individually with seven out of ten students who participated in all activities of the program. Seven students interviewed are four 8th graders (A3, A4, A5, and A6) and three 9th graders (A7, A8, and A10). While participating in all processes of the project activities, these students are well aware of the intentions and themes of each stage of the program. Their thoughts and opinions were well reflected in their project outputs.

The entire process of the interview was recorded, and it was converted into text using a recording management service, using artificial intelligence voice recognition technology, and errors were corrected by confirming it with the actual voice. In-depth data were analyzed in relation to how the project-based club program influenced students' changes to deal with climate change and the results were drawn.

Research Results

Knowledge Related to Climate Change

Knowledge related to climate change is about climate change itself, such as the main causes of climate change (natural and artificial) and various consequences of climate change (social, environmental, economic, etc.), and knowledge of how to deal with climate change. Students answered about what climate change is before starting the project-based club program as a pre-test. Most students did not recognize what climate change meant as they described it vaguely. They answered the question with short answers such as garbage, air conditioners, global warming, storms, showers, and so on. The results from interviews after the program with students are as follows.

Teacher K: Did you learn anything new about climate change or carbon neutrality through the club activities?

Student 7: Before the club activities, I did not take climate change seriously, but after the club activities, I became to know that climate change is serious.

Student 4: While studying and working on climate change and carbon neutrality, I realized that climate change requires more attention from us than I originally knew and that we can solve it only when we take action.

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Student 8: Originally, I did not know about carbon neutrality, but through this club activity, I learned about carbon neutrality itself, and now I know that carbon neutrality is important for us to prevent climate change.

After the program, students were able to elaborate on their knowledge about climate change. Student A7 replied that he learned how serious climate change can be while participating in club activities. Student A4 also replied that the climate change problem could be solved when the members of society showed concern and willingness to take action. Through these answers, it was confirmed that their prior knowledge was improved. In addition, student A8 said that he was able to obtain a clear concept of carbon neutrality, which was very vaguely conceptualized before the program.

Sensitivities to Climate Change

Sensitivity to climate change implies that individuals recognize the values of the natural environment and the earth system, respond sensitively to climate change, and have a concern about targets (people, environment, and society) damaged by climate change. It also implies that individuals understand targets and feel empathy for them. When students were asked about how climate change affects them, their answers appeared as 'food becomes scarce, 'arctic glaciers are melting', and 'four seasons are disappearing.' It was revealed that students perceive climate change as a problem in general but not directly influencing on their daily lives. Some students' sensitivities about climate change drawn from interviews are as follows.

Teacher K: How did you feel when you discussed and predicted drastic changes in locations suitable for growing apples?

Student A7: I felt sad when I predicted that my parents are no longer able to grow apples after just a few years. The sad feelings remain in my mind.

Student A4: Looking at the map to show suitable locations for growing six major fruits, there are fruits that I can't eat any more after a little while. Now that I feel that these things are no one else's business, they are coming soon to me as well. I have been able to act with awareness as much as possible, and I have tried to make people aware of this fact by addressing people at the Apple Festival. I tried to tell the truth.

Student A6: It helped me to know how much damage climate change is doing to our daily lives. I think these activities have helped raise awareness about climate change.

Shin and Shin (2021) argue that developing sensitivity to the environment is the beginning of change, and the first step in environmental education is to start by knowing that one is related to the environment. For this, it was said that it was necessary to enhance the sensitivity to accept the change in the environment as one's own. When environmental ecological sensitivity is the basis, we can respond sensitively to changes in the natural environment, and we can think about the seriousness of climate and environmental problems. The increase in sensitivity to climate change through this process would have been the basic driving force to lead the cultivation of action competency in dealing with climate change.

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Reflections on Climate Change Activities

Reflecting on climate change can be an important first step towards taking action to address the issues. Reflection is a process of thinking about and evaluating experiences, events, or information in order to gain a deeper understanding or insight. For the question, 'Have you ever done anything that worsens climate change and what have you done?' in the pre-test, students answered 'no' or with simple words such as 'just throwing garbage,' or 'leaving food behind.' However, their levels of ability to reflect on climate change after the program became articulated. Students' changes in reflections on climate change drawn from the interview after the program are as follows.

Teacher K: You said that you learned about environmental activist Greta Thunberg through the club activities. What kind of person do you think this person is?
Student A5: I think it's great that Greta Thunberg walked the path of an environmental activist at such a young age. And if I get a chance, I want to be an environmental activist like Greta Thunberg.
Teacher K: What kind of behavior did you change through the campaign and if you do another campaign, what kind of campaign would you like to try?
Student A8: I learned about various alternative energies to reduce energy. I want to do a picketing activity with the theme of using alternative energies in the city. I will do this at the busiest spots where many people come and go.

It was confirmed that student A5 learned about behaviors of teenagers in responding to climate change through the case of environmental activist Greta Thunberg. Even further he explored careers related to the environment. He seemed to be motivated by knowing an example of the participation of the peer group in climate change activities. In the case of student A8, he responded that he was able to change individual behaviors by conducting a climate change campaign. Through this, it was possible to see that students were exploring their own ways for a sustainable future while looking back and observing individual behaviors through club activities.

Communication Abilities

In resolving climate change, communication ability is necessary to respect and accept the opinions of various topics in society and to effectively communicate one's own and others' thoughts and feelings. Students' changes in reflections on climate change drawn from the interview after the program are as follows. From the pre-test data in relation to this communication ability, most students were exposed to news related to climate change mainly through media such as news (broadcasting, articles), YouTube, and SNS. It was difficult to see cases where topics such as climate change were discussed in everyday life outside of the media. After the program, students' changes in climate change at interviews were revealed as follows.

Teacher K: It was said that taking into action in a group had a greater influence on climate change than acting alone. What part do you think had an impact?
Student A6: If I had done it alone, I wouldn't have actually practiced it, and even if I had done it, I wouldn't have done it properly. But since I did it with my friends and high graders, I

became more confident and the range of activities I could do broadened and grew. I was able to realize it better and I think it helped me when I decided to act on climate change.

Teacher K: Did you meet people who are interested in the environment at the Apple Festival and have your thoughts changed? Please tell me if there is.

Student A6: At the apple festival, a grandmother came, and we were explaining about climate change. Because I thought people were only thinking about it and not many people were actually interested in it, but I was very surprised that there were people like that, contrary to what I thought.

At the interview, student A6 replied that he was able to gain confidence while communicating with seniors and classmates, which he could not have done alone. It was also confirmed that the scope of activities was expanded than he thought in the process of collaboration. In particular, students carried out the project output to perfection while actively sharing and communicating with each other through activities such as data research, article coverage, and article composition for the production of ECO-TIMES. In addition, through conversations with people who expressed interest in the environment at the Apple Festival during the SPEAK UP activity, students improved their degree of interest in climate change and were determined to change their behaviors. They improved action competency with such thoughts.

Decision-Making Abilities

Decision-making ability refers to the ability to the skill of evaluating options and selecting the best way to achieve a specific goal to adapt and mitigate climate change. In this regard, the data from the pre-test, students responded that it was possible to solve climate change, particularly, students mainly answered that 'it can be solved in the direction of changing individual behavior.' After the participation in the club program, students' responses at the interview are as follows.

Teacher K: You said that the climate change problem should be solved globally, is there a reason you think so? Then, please tell us what efforts can be made to solve this problem globally.

Student A3: Since climate change is now a global issue, not just one region or one country, I think we should do it together globally. In addition, in these days, the Internet media is well developed, so it would be good to publicize it through the Internet media and act as a stimulus to inform the seriousness of climate change.

Teacher K: Shall we talk about how to promote carbon neutrality to those who have not yet practiced it?

Student A4: I would like to show people who are not practicing carbon neutrality a climate crisis-related video about what happens if they do not practice carbon neutrality, so that they realize its seriousness.

Student A3: I think I can play a role in promoting and informing people about ACT NOW's living rules on saving energy at home by writing an article or something like that on the Internet.

Student A6: First of all, I think we should convey exactly what kind of damage has occurred due to climate change. Because, honestly, I didn't think there would be such a big damage, and thanks to the NT2050 activity. I have an idea to practice more carbon neutrality. In particular, it would be nice to approach the younger generation through SNS.

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In the case of Student A3, it can be confirmed that he recognizes the climate change problem as a global problem as well as an individual one. In order to solve this problem, a decision should be made to use the Internet as a medium to share and inform the seriousness of the climate change problem. It was also confirmed that the problem of climate change is thought to be a problem that can be overcome with global efforts. For the case of Student A4, he suggested using climate crisis-related videos as a way to promote carbon neutrality. Moreover, Student A6 also suggested that clear facts be conveyed about the damage caused by climate change. He was convinced that the cases of damage caused by climate change are bigger than he thought, and he learned about this information through club activities and developed a willingness to share it with teenagers of his age through SNS.

Willingness to Act Climate Change Mitigation Activities

The willingness to take action refers to a person investing time, money, and energy in individual and social practices to solve climate change problems with critical thinking about climate change. For the pre-test data in relation to this willingness to practice mitigation activities, students were able to identify responses that actions were mostly temporary, non-continuous, and cost-free. Their willingness to deal with climate change problems was not so great before the program. After the program, students' changes in terms of willingness at the interview are as follows.

Teacher K: Do you think individual action is important to respond to climate change? If so, can you explain why?

Student A4: The reason why I thought that individual action is important to respond to climate change is that each of us must take action to change, not just one person acting. It's not just me, I think everyone should practice individually now.

Student A5: In order to respond to climate change, I think it is important that if we start as individuals, we can become the whole. What I did at school lunches was to eat but nothing left or eat more vegetables to reduce the use of food resources. And what I felt through what I practiced was that I felt proud that I had contributed a little more to this carbon-neutral challenge.

Student A8: I think individual practice is important. The reason is that individual actions can save the earth, and individuals can come together to change the world.

Students responded positively that climate change can be solved through practice in club activities. In particular, in the way that A4, A5, and A8 students all answered that the theme of solving climate change is not only the individual but also the world, it was confirmed that the scope of the theme to solve the problem of climate change is expanding. Through this, it was confirmed that the club activities are effective for middle school students in having the perception of building governance as an action competency to solve the climate change problem.

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Discussion

This study is to explore how a project-based club program influences middle school students' action competency in responding to climate change. For this purpose, changes in students' thoughts on action competency were analyzed through a pre-test on their prior knowledge, a teacher's observation journal recorded and collected during teaching and learning activities, project outputs, and in-depth interviews at the end of the project-based club program. The main research results in this study are summarised and discussed as follows.

Most students in this study were able to articulate concepts and knowledge about climate change and carbon neutrality after participating in club activities. Their sensitivity to climate change was improved and in turn, led to nurturing their action competency to respond to climate change. Further, students were able to search for their own way while observing and reflecting on individual behaviors. Students also gained confidence by communicating with their seniors and classmates. The process of these project-based club activities played a positive role in respecting and accepting various opinions and effectively communicating thoughts and feelings with others in resolving climate change. Such results were in line with the previous research in Korea that students' changes in awareness, sensitivity, and involvement in environmental issues resulted from project-based environmental education (Hwang et al., 2014).

Students recognized the climate change problem not only as an individual but also as a local and global problem. This was helpful in improving decision-making ability on how our society should act in terms of adapting and mitigating climate change. Students represented a willingness to accept that climate change can be solved through practice through club activities. They further explained that it was not only individuals but also the world that must solve the climate change problems. Similar results and discussions about changes in behaviors also appeared in a study of community-based SSI programs in domestic (Kim & Lee, 2017) and in a study about everyday activities abroad (Gould et al., 2019).

Conclusions and Implications

This study attempts to approach the issue of climate change in an educational way. It is necessary for students as future citizens to feel personal awareness of global environmental issues and responsibility as global citizens. Action competency in climate change implies an individual or organization's ability to effectively take action to mitigate the impacts of climate change. It involves not only having the knowledge and awareness of the issue, but also the skills and resources necessary to create and implement solutions. The study with the goal to nurture middle school students' action competency in climate change developed a project-based club program and implemented it for ten middle school students. The students in this study were able effectively to make changes with better understandings of knowledge in climate change and carbon neutrality, improved sensitivities to climate changes, enhanced reflection, communication, and decision-making abilities and a strong willingness to take into action for solving climate change problems.

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Although the project-based club program in climate change developed in this study could not be a model that represents all the project-based programs, but it can be a guide for student-directed project programs, especially for developing action competency in climate change. In order to promote project-based educational activities in climate change education, teacher education and training programs should be continuously provided. Furthermore, other effective teaching approaches in climate change education should be developed and diffused.

Declaration of Interest

The authors declare no competing interest.

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