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Review Article

The Review Study of Environmental Education Curriculum in Climate Change Mitigation

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Abstract
Indonesia is a country whose geographical location is on the equator, has many islands and tropical forest areas, and is surrounded by volcanoes. Indonesia also has a high potential for natural disasters, such as volcanic eruptions, floods, tsunamis, forest fires, etc. Therefore, it is necessary to introduce early on how to mitigate and adapt to disasters due to climate change. Through education, integrating mitigation and adaptation to climate change will get along with the national education curriculum in Indonesia. The problem in this study is how the concepts of climate change mitigation and adaptation learning models can integrate into the national education curriculum in Indonesia. The goal is to find an ideal model framework for implementing climate change mitigation and adaptation lessons in the national education curriculum. The method used is qualitative, with a literature study of articles indexed in Scopus. The results obtained are that the integrated model of climate change mitigation and adaptation learning can be carried out in several stages, namely: 1) mapping the types of disasters and their mitigation measures; 2) linking knowledge about climate change mitigation and adaptation with real examples; 3) inserting climate change mitigation and adaptation material into various subjects in schools.

Keywords: Adaptation; climate change; curriculum; environmental education; mitigation

1. Introduction

Global warming and climate change are complex problems to manage later in life, so mitigation must be done to reduce the causes. Global warming mitigation is a variety of active actions to prevent or slow down climate change or global warming through efforts to reduce greenhouse gas (GHG) emissions and increase GHG absorption(Arifanti et al., 2022; Goldstein, 2022; Heryandi et al., 2022). In this case, mitigation efforts are carried out to avoid problems that cannot be managed in the future. Mitigation is an effort to address causes to reduce the risks and impacts of future global warming and climate change.

The magnitude of the impact of climate change on aspects of human life encourages the need for literacy and strengthening of adaptation and mitigation. Climate change adaptation is understood as an effort to adjust to anticipate the real effects of change. This adaptation aims to alleviate the adverse effects of these changes so that humans are expected to find natural tips for self-adjustment activities. At the same time, climate change mitigation is an effort to reduce or reduce the risks and impacts of climate change. Efforts to adapt and mitigate environmental changes can be made by strengthening the field of education. It is because education is the foundation on which various climate change, adaptation, and mitigation issues are taught. In fact, until now, the issue of climate change is still only limited to specific topics in subjects such as science, geography, or matters related to the environment. Climate change is only a complementary topic to the many learning topics offered in the curriculum (Arwan et al., 2021). Strengthening the education sector is very important, considering that the generation that will dominate

the entire Indonesian population in 2045 is Generation Z, born from 1995 to 2010. In 2045, this generation will be classified as productive age (15-64 years), so it will be a democracy bonus from Indonesia because of its considerable growth rate compared to the unproductive period. Seeing this phenomenon, demographic bonuses, including the potential of Generation Z in Indonesia, must be appropriately utilized to realize the vision of Golden Indonesia 2045 in environmentally oriented human development. Thus, as part of Generation Z, students have an essential role in taking part and taking concrete actions so that climate change knowledge is very appropriate to be included in the curriculum. Research results mentioned that Generation Z has an essential role as an agent of environmental change by influencing other generations to participate in implementing *green behavior* and realizing healthier environmental change (Sudaryono & Kartika, 2022). Through education for sustainable development (ESD) at the level of education that enables every person to gain knowledge, skills, attitudes, and values that shape sustainability in the future, internalization efforts for eco-friendly behavior in Generation Z can be made.

The main principles of climate change-based education include understanding climate change, adaptation, and mitigation (Arwan et al., 2021). These three topics must be supported by all learning activities, reflections, and connections between students and learning resources related to climate change that can be managed more broadly. Furthermore, climate-based education focuses on improving education, awareness, and human and institutional capacity of climate change, mitigation, adaptation, and impact reduction and early warning.

The science lesson mentions the objectives of science learning in the Independent for fostering interest and curiosity; protecting, preserving, and properly managing the environment; and fostering the development of problem-solving abilities through the use of inquiry processes. Then, also comprehend what it means to be a part of the community of the country and the world and acquire knowledge of and an understanding of scientific concepts (Sartika & Wiguna, 2022). According to the research, implementing the Independent Curriculum has several benefits, including allowing teachers to be creative and imaginative in the classroom and requiring students to complete class projects that would challenge them to learn (Nikmatin Mabsutsah & Yushardi, 2022). Through the educational process, it is hoped that it can help every student as a community member with awareness and sensitivity to environmental problems. Environmental care behavior in the community, in general, can be seen from three indicators, namely water use, energy use, and waste management (Lustiyati et al., 2023). Understanding the importance of maintaining and preserving the environment so that it is maintained and balanced in life on this earth needs to be understood. It must be instilled in understanding generations.

Through this research, we will fill the research gap linking climate change adaptation, which is integrated into formal education. Studies of scientific papers show that environmental education has been incorporated into national curriculum and supported by educational policies in a number of nations in an effort to adapt to climate change brought on by global warming. Therefore, the national curriculum in Indonesia needs to emulate this. It is essential to integrate environmental education with the national curriculum because the impacts of climate change and ecological damage are increasingly being felt. Environmental education must be introduced early for the next generation of the nation's successors. The primary medium for teaching this is through education from an early age to adulthood. Therefore, the education curriculum in Indonesia needs to integrate environmental education into school subjects to educate students about the importance of preserving nature and adapting to the impacts of climate change.

The integration of environmental education is not only in the form of material content but also through interactive learning activities utilizing surrounding ecological media such as outdoor activities. The aim is for students to understand through learning materials and internalize essential values about the environment and the impact of climate change through experience and interaction with the surrounding environment. Integrating environmental education into the national curriculum can be carried out through the introduction stage of ecological aspects and the impact of its damage, then

preparing content in learning materials in the form of special modules about the environment, followed by the practical stage of direct experience with the environment through learning activities outside the classroom by utilizing various media in the surrounding environment.

Thus, education can effectively lower the risk of disaster by requiring all students at all levels to take a lesson on natural disasters, especially in institutions that are located in high-risk locations. (Faizal et al., 2022). Therefore, the problem to be discussed in this study is how to integratee knowledge about climate change mitigation and adaptation into the national education curriculum. The goal to be achieved is for students, as part of the demographic bonus, to gain knowledge about the impacts, mitigation, and adaptation of climate change from the beginning through learning activities in formal education.

2. Methods

2.1 Data Collection and Selection Criteria

The research method used is qualitative by using a Literature Study of scientific articles in journals or books indexed by Scopus. Finding documents that are relevant to the research topic is how the initial research stage is carried out. The Scopus database, which was retrieved on May 6, 2023, was searched for metadata and article information in order to identify these publications. The following criteria were used to choose which documents to include in the Scopus database: 1) the keywords, including school curriculum, climate change, and mitigation, and 2) the articles published from 2013 to 2023 (40 documents). The next stage is the screening process was limited for the documents found based on 1) subjects covering social sciences, environmental science, multidisciplinary, arts and humanities, and decision sciences (29 documents); 2) english language documents (28 documents); 3) document types in the form of articles, book chapters and conference papers (27 documents); 4) source documents originating from journals, anthologies, books, and proceedings (27 documents). The final results of the screening stage were then downloaded for a review stage of their contents according to the research topic. During the article download process, four articles could not be obtained, so there were only 23 documents to be reviewed. At the review stage, the contents of articles related to environmental education, climate change, and mitigation adaptation are examined. Six documents did not match the research topic at this review stage, so the final result was 17 documents that would be processed further with the viewer application.

2.2 Data Analysis

Selected publications' bibliographical details were exported in CSV format from the Scopus database into VOS viewer version 1.6.18. Then, a bibliometric map is created by looking at keyword co-occurrence. Analysis of this keyword was chosen because it represents the main topic in each scientific discipline discussed in a scientific article. Therefore, keyword co-occurrence analysis can show the relationship between keywords shown by connected or non-connected curved lines in the network visualization. This analysis of network visualization shows that there is a potential research gap that can be studied further. Network visualization analysis is carried out qualitatively by mapping keywords that still need to be connected. The counting method used in this bibliometric analysis is full counting. Then, set the minimum co-occurrence keywords at number two. The aim is to see in more detail the repetition of each keyword for at least two occurrences to clarify whether each keyword is connected or not. Then, the article's content is analyzed using content analysis to obtain essential findings related to the research topic. This method is considered robust for conducting a study to find research gaps and other important information in a scientific document to answer a problem in research (Suprayoga et al., 2020).

3. Result and Discussion

3.1. Literature Study of Implementation of Climate Change Knowledge in the Education Curriculum

Searching for articles based on the protocol described in the method has yielded 17 documents for further review. Of all these documents, yet to be Scopus-indexed publication originating from Indonesia discusses the application of environmental change insights in education. Therefore, this literature review wants to show how the development of climate change knowledge integration in various countries' education systems. And also, with Vosviewer application can see the relation from each author keywords. The advantage from knowing the relation from each keywords, that can help to find the research gap based on the topic in this study. Figure 1 below show the occurance from each author keywords.

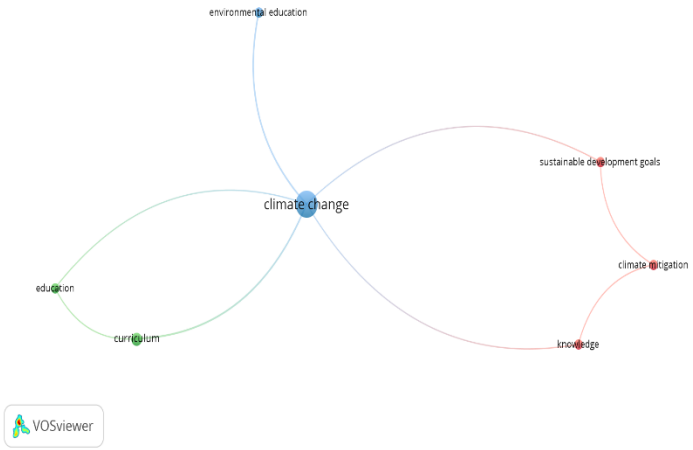

Figure 1. Co-occurance author keywords
Source: (data processed, 2023)

From the figure 1 above we can see that some keyword not directly connected such: 1) environmental education and climate mitigation; 2) environmental education and sustainable development goals; 3) curriculum and climate mitigation; 4) environmental education and knowledge. So, this study will fill the research gap by literature study with connecting the keywords for environmental education, climate mitigation and curriculum. Table 1 below shows the results of a literature review of documents obtained from Scopus based on the protocol implemented.

Table 1. Review of climate change education literature in various countries

No	Location	Method	Finding
1	Guyana	Survey	- To guarantee that teachers have the necessary knowledge base, attitudes, and pedagogical abilities, teacher education and training, particularly about teacher preparation and competencies, must be the foundation for the successful infusion and delivery of climate change education. - The necessity for a national policy on climate change education cannot be emphasized enough given that such a "blueprint" will not only outline the learning objectives needed for each age group but will also lessen the likelihood

No	Location	Method	Finding
			of sporadic and uncoordinated responses to the need to integrate climate change into our schools (Bynoe & Simmons, 2014)
2	Philippines	Quantitative (survey)	There is wisdom in engaging teachers and students in tackling knowledge relating to climate change adaptation (Manalo et al., 2016)
3	Australia	Literature study	- Global warming Education must draw from the new informal and hybrid spaces that provide alternate opportunities for learning and action rather than being restricted to traditional institutions and formal curricular settings. The need to understand the meaning of climate change for teacher and student. - The need to explores for mitigation and adaptation of climate change in the local and global level. (Stevenson et al., 2017)
4	United States	Quantitative-Qualitative-Ethnographic	Schools should serve as gathering places for the community and natural learning centers, and students can act as resources for adult and family engagement in behavior change initiatives. (Siegner, 2018)
5	Zimbabwe	Case study	- To keep local social-ecological systems resilient, Indigenous Knowledge System (IKS) is essential for community-based adaptation and mitigation measures. - - Teachers and young students should be the first groups to learn about climate change through IKS, along with their roles in helping them comprehend its effects and variability. (Tanyanyiwa, 2019)
6	Sub-Saharan Africa	Literature Study	The framework for controlling the impact of environmental change can be carried out in three stages, namely (Rother, 2020): a. Mitigation by reducing greenhouse gases and increasing the use of green energy b. Adaptation can be done by increasing education and training professionally about the impacts of climate change c. Communication can be done by drafting regulations to prevent the impact of climate change on the environment, socialization through various media about climate change
7	Nottingham, United Kingdom	Case Studies	The degree or scope of the intended influence must be taken into account while developing initiatives or programs in the field of education(Molthan-Hill et al., 2020).
8	Czech	Quantitative (survey)	One's willingness to act and subsequent behavior in a specific pro-environmental action can be influenced by a variety of factors, including personality, past experiences, education, actual and practical knowledge of the issue, cultural, social, and family background, cultural and religious tradition, and political climate(Lehnert et al., 2020).
9	Canada	Quantitative (survey)	Activities and lifestyle decisions could reduce climate change initiatives, such as the establishment of high school curricula (Pickering et al., 2020).

No	Location	Method	Finding
10	Caribbean	Qualitative (interview)	The project assisted students' coursework at school and required them to practice and apply scientific concepts and methodologies in their local communities (Selby et al., 2020).
11	General	Literature study	primary and secondary schools' ability to teach about climate change depends on their collaboration with universities (Reimers, 2021).
12	England	Quantitative (survey)	Teachers in England promote a more expansive vision of an interdisciplinary environment for combating climate change that integrates social justice and participation in social action into the academic program. The Early Years and Key Stage 1 should be the first grades to introduce climate-related conservation and mitigation programs (Howard-Jones et al., 2021).
13	Greece	Quantitative (survey)	the need for "natural sciences" curriculum reform, current and modern methods of instruction, environmental education initiatives, outdoor learning, and teacher education to improve students' comprehension of "natural sciences" (Ganatsa et al., 2021).
14	Himalayan	Case study	To encourage students to be more proactive in adaptation and mitigation measures, formal education should place a greater emphasis on climate change, with appropriate changes to curricula and pedagogy (Zeeshan et al., 2021).
15	Canada	Case study	An advocacy campaign to encourage better understanding and formal educational activities on climate change and health among medical students includes education-related activities, didactic lectures, and interaction with the medical school administration to support curricular activities and resources on climate change and health (Hansen et al., 2021).
16	Pakistan	Case study	Stages for implementing climate change education(Japanwala, 2021): Phase 1: Context Teaching pupils about climate change is the initial part of the curriculum. 2nd stage: adaptation To comprehend how climate change is having an impact, Third Phase: Migration The first type of this phase involves preparing students emotionally, while the second involves preparing them practically. 4th stage: advocacy Teaching kids self-advocacy skills is crucial for the last phase because, if necessary, they should be able to lead public protests and engage with local officials in addition to demanding better resources and negotiating if they must move.
17	UK	Mixed method	Many students expressed their appreciation for the teaching of practical applications of the module's material, such as how individuals may influence the sustainability of healthcare, and how this would enhance the value of further iterations of the module (Dunne et al., 2022).

Source: (author elaboration,2023)

From Table 1 above, various models step in integrating climate change education in schools. In applying to learn about climate change should pay attention to the following dimensions (Arwan et al., 2021):

a. Mitigation

Identification of the causes of climate change, development of knowledge and abilities regarding the dispositions required for personal and social transformation, and amelioration of the causes of the effects of climate change are all part of the mitigation dimension of climate change-based education. For example, on the topic that one of the causes of climate change is greenhouse gas emissions, then learning activities begin to increase competence related to knowledge of types of energy consumption, involvement of economic systems, expectations of changes in human lifestyle, and causal relationships between greenhouse emissions and various phenomena that occur.

b. Adaptation

Building resilience and lowering susceptibility in the face of immediate or long-term effects of climate change are the goals of the adaptation component of climate change-based education. Adaptation can also be taught through knowledge sources based on local wisdom or *indigenous knowledge*. The skills and values of local wisdom traditions towards the environment are selected with the criteria of local wisdom that can build a culture of safety and survival.

c. Understanding and Attention

Often the threat of climate change is not felt directly but slowly has a negative impact that is detrimental to sustainability and resilience. The dimension of understanding and concern is about understanding what is happening in climate change, understanding the factors behind climate change, and how to strive for vigilance and caution towards the impacts that may occur during climate change. Furthermore, through this understanding and attention, education must be strengthened with climate change-based literacy. Students are invited to be critical, have problem-solving skills, and think critically about appropriate or erroneous information and how to strive for the needed actions and attitudes.

Learning about climate change is part of ongoing education to preserve nature and the environment. There are three guiding principles for developing sustainable education: 1) engaging in teaching and learning activities that can increase teachers' and students' knowledge of natural resources and sustainable development; 2) requiring schools to take action steps to support students' awareness of critical values, democratic processes, and social inclusion in developing sustainable practices; and 3) taking community-level initiatives to support schools and other or other organizations in developing sustainable practices (Jóhannesson et al., 2011).

3.2 The Urgency of Integrating Disaster Education into Learning Materials in Schools

The basic needs of human life include food, water, clean air, and shelter (Chiappero-Martinetti, 2014). Therefore, humans depend on the environment to meet these basic needs(Fedele et al., 2021). The natural environment around humans has many benefits, especially in supporting the sustainability of human life. For the natural environment to sustainably support human life, development programs are needed that minimize their negative impact on the environment through sustainable development (Dogaru, 2013). The development carried out aims to increase the utilization of resources for human welfare.

Population growth and technological developments make the availability of natural resources increasingly limited. It forces humans to think about priorities for fulfilling the basic needs of present and future generations (Després & Bouget, 2019). Thinking about meeting the needs of future generations, of course, is closely related to population growth and technological development. Population growth and natural resources are closely related and affect climate change (Dogaru, 2013). For the natural environment to continue to provide natural resources to fulfill its life, humans must be able to preserve nature. Efforts to preserve nature are synonymous with safeguarding the future of humans because nature can provide the resources needed for human survival (Muñoz et al., 2019).

In addition to providing the potential to meet human needs, the natural environment can pose various disaster threats that endanger humans. The threats of natural disasters include floods, droughts, earthquakes, and heat waves (Raju et al., 2022). Various devastating natural disasters have disturbed human tranquility, including large-scale eruptions with volcanic explosiveness indices (Mani et al., 2021), and an observed tsunami with a runup higher than 20 meters (Kodaira et al., 2021). Natural disasters due to natural environmental hazards can result in death and illness, and over the past decade, there have been more than 300 natural disasters around the world (Prasad & Francescutti, 2017). When they occur on a huge scale and are brought on by earth's natural processes, which frequently cause death, trauma, and property destruction, natural disasters become exceedingly harmful (Saeed & Gargano, 2022). The large number of casualties due to this natural cause makes humans must be able to take rare steps to minimize casualties. One of the steps that can be taken includes mitigating natural disasters. Although overall disaster risk is difficult to eliminate, risk mitigation can minimize the adverse effects caused by disasters (Tay et al., 2022).

By understanding the potential of disasters, the community can take steps to prevent, handle, and overcome disasters. Through disaster management, education can create a safety culture by involving community members (Seo et al., 2021). Disaster education starts from formal education (elementary school, junior high school, advanced secondary school) through programs and curricula according to the level of education. Education is also a strategic means to introduce potential disasters and their risks to every student to be aware of natural disasters to preserve the natural environment (Tahmidaten & Krismanto, 2019). several climate change materials that can be divided into three learning materials as follows (Sartika & Wiguna, 2022).

a. Global Warming

An increase in carbon dioxide in the atmosphere as one of the greenhouse gases can cause global warming. The following are the factors causing global warming: 1) increased emissions of greenhouse gases; 2) pollution in the oceans; 3) logging and burning of forests without reforestation; and 4) polar ice caps melting due to increased temperatures in the atmosphere.

b. Climate Change

If global warming continues to occur, then some of the impacts of climate change are as follows: 1) earth's temperature is increasing; 2) melting polar ice; 3) high sea levels; 4) shifting seasons and rainfall. With the number of losses arising from natural disasters, students need to know about mapping the types and efforts to mitigate these disasters. Mapping disaster types is essential to understand the types of disasters, their nature, and the level of risk that an area can face. Through disaster education, students can understand the potential for disasters to occur, how to avoid disasters, prepare themselves in the event of a disaster, and try to minimize the impact caused by the disaster (Tahmidaten & Krismanto, 2019). Disaster education can change pro-environmental behavior that is cheaper than technological engineering. Pro-environmental behavior is a person's effort to reduce the negative impacts caused by natural damage, namely by repairing and preserving the environment (Seo et al., 2021). Furthermore, it can help individuals prepare for long-term catastrophes, enhance students' disaster knowledge and abilities in coping with disasters, improve disaster preparedness, and minimize vulnerability to disasters (Septikasari & Ayriza, 2018). Disaster education can be implemented through integration into the educational curriculum, integration into local content, and integration into student self-development (Septikasari et al., 2022), or the integration of disaster materials into student learning materials (Al-Nasr, 2015).

Disaster education is essential to implement. Some of the reasons for the importance of integrating disaster education into learning include: a) because currently, students' knowledge of disasters, disaster preparedness plans, early warning systems, and resource mobilization remain below 60, or in the poor category (Hafida, 2019), b) There is still a lack of integration of disaster materials into subjects(Al-Nasr, 2015); c) disaster mitigation and literacy in schools are still relatively low (Maliki et al., 2023),, and d) there is still little (15%) school preparedness in anticipation of earthquakes and tsunami (Satria, 2018). The

necessity of implementing a disaster curriculum at the primary education institutions stems from the fact that Indonesia has a high potential for natural disasters, which further emphasizes the significance of integrating disaster education. The catastrophe curriculum needs to include regional material to describe how people interact with the local environment and culture (Desfandi, 2014).

3.3 Implementation of Climate Change Mitigation and Adaptation in the National Curriculum

Strategies in dealing with climate change need to be developed and directed at social engineering so people can experience changes systematically and plan. The key to climate change is adaptation. Adaptation must be a development agenda that is resilient to climate change impacts that occur today and anticipates future impacts. There are two forms of learning models suggested to impart knowledge about climate change, namely (Faizal et al., 2022):

a. Conservation education is included in environmental education, which contains the understanding of a process aimed at building the spirit of the world's population who are aware and pay attention to the environment, including its problems. Furthermore, with conservation education, they are expected to have the knowledge, motivational attitude, commitment, as well as the ability to work independently and in groups to solve present problems and prevent future ones.
b. Outdoor class strategies in learning to deliver students to their maximum potential because this strategy is fun in various forms of challenging *touring*. The element offered in the outdoor class strategy is learning while following the exploration in a fun way. Learning through the process of experiencing themselves and *interacting* intensely with their friends in the outdoors is indeed a meaningful experience and difficult to forget. Outdoor classes always give birth to new experiences that will shape student development and, in the future, will form a fun character to apply in everyday life.

The adoption of knowledge about climate change mitigation in the world of education is not a new thing in the world. In some countries like Australia, Israel, Finland, Bangladesh, Canada, and England, a national curriculum already integrates knowledge of climate change mitigation and its adoption practices. In practice, all countries must regularly reevaluate their green policies to mitigate climate change effects. An apparent example of this cause is a study about climate change mitigation in Australian education. Pre-service teachers in Australia, one of the affluent countries promoting green politics, have a gap in their knowledge and perspective of climate change. A survey found that there should be more trust in sources of climate change information, and that more than half of all respondents had a low degree of awareness of climate change(Boon, 2014). It is worth noting that Australia is advanced in its education effort to tackle climate change effectively. The Australian education system has a collection of climate change education resources, such as the Children's Books Daily website that provides over 100 books on sustainability for children.

Then developed Enviro-Tech teaching materials in South Africa(Vogel & Schwaibold, 2015). The purpose of this teaching material is to provide critical resources for teachers with limited access to teach, train and provide material facilities on climate change. The South African Department of Environment supports enviro-tech with support from the German and British Embassies. The knowledge content in Enviro Tech focuses on curriculum content (content on climate change is associated with the 10th-grade curriculum in junior high school). It has aspects: transformative learning related to energy change, food/beverages, and action for climate change. Educators generate the material. At Enviro-Tech, students are asked to think about the current environmental conditions they know. Then they are invited to imagine how their environment will be 20 years into the future. Usually, what will arise is a negative impact on the environment, such as pollution, poverty, and crime. However, students must also be invited to imagine positive things by making efforts to preserve the environment. So that students not only know negative things but are also encouraged to do positive things.

This issue is the main problem with Indonesian climate change mitigation education. Education must provide clear and understandable definitions and actions for mitigating and adapting to climate change. As noted in the study access to obtainable materials is still one of the primary issues(Nurdin et al., 2017). Even though the new curriculum, the 2013 Indonesian Curriculum, has shown its enhancement in better educational support for climate change awareness, there is still room for improvement. The issues are a lack of policy support at the school level, a lack of encouragement from stakeholders, and the fact that present regulations do not obligate teachers, principals, students, or parents to implement climate change. It is also worth noting that students' capacity to distinguish between mitigation and adaptation to climate change is rather low (Bofferding & Kloser, 2015)..

Mitigative responses can be characterized as adaptations in several circumstances. Nonetheless, students' knowledge of adaptation to climate change is primarily about changing one's lifestyle, such as using less energy. Meanwhile, it makes them more vulnerable to the effects of climate change. In terms of climate change education, it is the fundamental knowledge for pupils. Meanwhile, a study (Colliver, 2017) stated that five groups of subjects become The Sustainability Cross Curriculum Priority, namely Geography, Science, Design and Technologies, and Civics and Citizenship (CC) education. Applying the framework to subjects must also adhere to components of the curriculum. The components consist of objectives, content, organization of teaching and learning experiences, or method and evaluation. The objectives are the goals that guide the process of organizing education. The contents are about learning materials that students will acquire throughout the lesson. The methods are the patterns used in designing the curriculum. The evaluation is the last part of the teaching process, in which the whole curriculum will be assessed in terms of its effectiveness. This table shows an example of integrating climate change mitigation and adaptation in the curriculum.

Table 2. Example of integrating mitigation and adaptation of climate change in curriculum

Subject	**Components of Curriculum General**		**Mitigation**	**Adaptation**
Geography	Objective	Describing region based on basic geography science	Describing ways to prevent a change in landscape	Describing various adaptive ways of living in extreme places
	Content	Mention location, the character of the landscape	Mention efforts to prevent the decline of land surface	Mention various manufactured landscape
	Method	Direct method	Demonstration method	Project method
	Evaluation	Pretest-posttest	Pretest-posttest	Pretest-posttest

Source: (author elaboration, 2023)

The table is merely a sample of the holistic curriculum about climate change mitigation and adaptation that can be integrated into school subjects. The curriculum was developed using the Merdeka, newest Indonesian curriculum, with some adjustments based on climate change mitigation and adaptation. Nevertheless, educators must be able to develop their own curricula based on students' understanding and national curricula. It is also based on a study that students were more likely to identify adaptation strategies that were personally relevant to their contexts (Bofferding & Kloser, 2015). Thus, the teachers, as facilitators, must ensure that students' potential to think critically about the mitigation and adaptation of climate change can be achieved. Meanwhile, the stakeholders should provide prepared

materials about climate change mitigation and adaptation that are accessible for students and teachers to learn about.

The school zoning program implemented by the Government of Indonesia is also a program that can support greenhouse gas mitigation (Sarkadi et al., 2020). The school's zoning program wants schools in a location to educate students within 6 km of the school(Sulistyosari et al., 2023). Taking into account the annual growth of personal vehicles of 10%(Putra et al., 2020), the school zoning program will be very contributive to the environment. At the ideal level, the consequence of this policy is a reduction in vehicle mileage to reach school. If the distance is traveled using fossil fuels, it will reduce greenhouse gas emissions compared to emissions that would have occurred if students had traveled longer to school in the past. For students who travel that distance by mass transportation means sharing with other communities in reducing greenhouse gas emissions. Students who reach their school by bicycle and on foot have stopped greenhouse gases from transporting to school.

Biology practice needs to include planting tall trees that sequester carbon for each student. This activity becomes an activity that applies throughout the year because students not only plant but are obliged to ensure that the trees they plant will continue to thrive until graduation. Schools must also actively incorporate a curriculum of planting one tree for each student. The school's effort is to ensure the type and medium of planting that is adjusted to the availability of land in the school with appropriate technology.

Preparing a curriculum for climate improvement that is active student participation will be more productive than a curriculum that is socialization and knowledge alone. A curriculum that is knowledge alone requires time to be conveyed to students, time for them to reflect on the right way to implement it, and the most challenging thing is to mentally raise students to apply the knowledge amid the opposite mainstream. An actively participatory curriculum will contribute directly when applied and become a space for knowledge transfer. The momentum of schools utilizing biogas installations by involving students as actors is at that time there is a reduction in greenhouse gas emissions and knowledge transfer about operationalizing biogas installations. When schools implement access to motor vehicle restrictions for students who have driver's licenses, greenhouse gas emissions will be reduced directly, and strategically, the growth rate of fossil fuel private vehicle ownership will be reduced. When students plant tall trees that absorb carbon, there is a reduction in the accumulation of greenhouse gases from the earth's atmosphere.

4. Conclusions

The literature review results for publications in the last ten years resulted in 17 scientific documents indexed by Scopus. The document discusses various model steps in integrating climate change education in schools. These publications are spread across various countries, and no Scopus-indexed publications from Indonesia discuss the importance of environmental education in dealing with the impacts of climate change. Integration the knowledge of mitigation and adaptation through national curriculum of independent learning must be done by transformative steps. This transformative step means that climate change education can be in the form of theory and see actual practice in everyday life. The context of climate change taught must be more than just material in several subjects. However, it must be integrated into other subjects by showing the facts of environmental conditions and their impact on the future. Some learning models that can be used such: conservation education, outdoor class, and developing enviro-tech teaching materials. It can be realized through environment-based learning modules that are integrated into various subjects with policy support at the local, national, and global scales. Globally, Indonesia has ratified the Paris Agreement to play an active role in reducing greenhouse gas emissions. Moving on from this, then nationally, joint policies can be formulated between several ministries with links in environmental impacts and changes with the Ministry of Education. For example, the Ministry of Education and Culture, Environment, Energy, and Human Resources can jointly formulate environmental and climate change-based education modules. After the policy, a local-scale policy can be

developed at the school level, where all teachers and students are expected to jointly integrate education about the impact of climate change into the existing formal curriculum.

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