

# Teaching Climate Change: A Systematic Review from 2019-2021

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**Abstract:** Climate change as a social issue challenged the disciplinary and methodological traditions of research. Moreover, climate change becomes more problematic as schools must be able to engage learners in learning situations that are challenging and rooted in geographical pedagogical traditions. Though it is present in the curriculum, the present study systematically reviews the teaching of climate change from selected literature from 2019 to 2021. The objective of this study is to investigate approaches and strategies in the teaching and learning of climate change as well as its integration across different learning areas in the basic education curriculum within a global continuum and the conception and operationalization of climate change education. Of the accessed meaningful related literature, the researchers selected one hundred fifty (150) pieces of literature further trimmed down into fifty-seven (57) and then to nineteen (19) from the year 2019 to 2021. The selection of literature is based on the following criteria set by the researcher: educational approach and implication, the methodology employed, and perspectives about climate change. Much of the present literature stressed science as a potent subject for discussing climate change, but others were covered as well, including climate education, arts, primary and middle school, after-school activities, and professional development. A systematic study of climate change, a model, computer games, classroom instructions, and learning capacities were all aims of the review. Teaching and learning approaches and strategies were identified. Methodology, perspectives, inferences, and recommendations were thematically discussed.

**Keywords:** Climate change, qualitative systematic review, curriculum, education,

## 1. Introduction

Henderson, Long, Berger, Russell, and Drewes (2017), opined that climate change from a global perspective unequivocally accepts that human is the primary cause of this. With present realities, educational researchers from several disciplinary and methodological traditions, as well as a variety of studies on environments, must contribute to this most important matter. The research field must recommit to a form of educational justice that is commensurate to the magnitude of the challenge. Cross, & Congreve (2021) linked other challenges to climate change such as mass migration, biodiversity loss as well as a threat to food security. The problem was not only in the basic education but across levels. Students must engage in complicated interactions, genuine learning situations including real-world challenges, and geographical pedagogical traditions. Authentic approaches are found to be effective; the scaffolding of skills substantially improves student performance. Environmental consciousness remains a powerful frame in teaching and learning. Thus far, Valencia (2018) assumed that Education for Sustainable Development (ESD) positions as a fundamental topic for educational institutions in the Philippines. Current attempts to implement ESD in the country include the integration in the curriculum where standards, as well as competencies, are being outlined. Culala and De Leon (ND) concluded that education and political authorities, as well as educators, needed to transform their knowledge systems, values, and beliefs. These modifications enable children to become more sensitive and aware of their surroundings. Sustainable education, as well as the curricular orientation of basic education, must be examined in critical debate. In the Philippines, understanding can modify behavior, raising

awareness of the anthropogenic causes of climate change, which may affect self-efficacy in decreasing the impact of human activity. The education effect on pro-environmental behavior is also explained by knowledge and beliefs regarding climate concerns, albeit to a lower amount (Hoffmann, & Muttarak, 2020). Ocampo & Buenviaje (2022) discussed the K to 12 reform efforts with the inclusion of kindergarten and the senior high school in basic education. The debate also included the development policy in basic education because of national development directions as well as global trends such that of globalization and sustainability.

## 2. Objective of the Study

Climate change has been the subject of numerous researches for several years. Furthermore, schools play an important role in realizing the Sustainable Development Goals as it also explicitly expresses climate action as one of its goals. As a result, the objective of this research is to investigate approaches and strategies in the teaching and learning of climate change as well as its integration across different learning areas in the basic education curriculum within a global continuum. Further, it also studies the conception and operationalization of climate change education as revealed in the pieces of literature.

## 3. Method

This study employed the systematic review with emphasis on the research objective which is to discuss the role played by schools in the teaching and learning of climate change vis-à-vis approaches and strategies in the basic education curriculum. The key search term was used, the keyword typed in the searched engine is “teaching climate change in schools”. A multistage review was utilized to appraise the

works of literature and development of data extraction and synthesis (Seers, 2015; Butler, Hall, & Copnell, 2016). About 2,860,000 results (0.12 sec) accessed as of January 08, 2022. Of the accessed and obtained meaningfully related literature, the researchers selected one hundred fifty (150) pieces of literature further trimmed down into fifty-seven (57) and then to nineteen (19) from the year 2019 to 2021. The selection of literature is based on the following criteria set by the researcher: educational approach and implication, the methodology employed, and definition and perspectives about climate change.

YEAR	NO. OF PIECES OF LITERATURE
2019	7
2020	11
2021	1
<b>TOTAL</b>	<b>19</b>

Munn, Peters, Stern, Tufanaru, McArthur, & Aromataris (2018) also provided indications for systematic review such as finding evidence, identifying current and new practices, classifying areas for future study, distinguishing conflicting results, and producing statements for decision-making. The said procedures for systematic review were also congruent with the steps and important choices suggested by Synder (2019).

#### 4. Qualitative Systematic Review

Stemming from the pieces of literature from 2019 to 2021, this systematic review examined various constructs in teaching climate change, including learning area, study objectives or purpose, perspectives, teaching and learning approaches and strategies, the methodology employed, inferences, and recommendations.

##### Learning Area Science

The researcher also categorized the learning area as the focus of the pieces of literature reviewed. Science was explored involving the teaching of concepts and skills relative to climate, environment, and sustainability (Smith, Besalti, Nation, Feldman, & Laux, 2019; Foss & Ko, 2019; Hestness, McGinnis, & Breslyn, 2019; and Clark, Sandoval, & Kawasaki, 2020).

##### Climate Education

This is followed by climate education as it specifically develops competencies concerning the environmental literacy of students (Monroe, Plate, Oxarart, Bowers, & Chaves, 2019; Waldron, Ruane, Oberman, & Morris, 2019; Cantell, Tolppanen, Aarnio-Linnanvuori, & Lehtonen, 2019; and Reis & Ballinger, 2020).

##### Primary School, Elementary Science, Middle School

Climate change was also taught and examined in primary school (Solís-Espallargas & Morón-Monge, 2020), and middle school (Sezen-Barrie, Miller-Rushing, & Hufnagel, 2020).

##### Science, Technology, Engineering, Arts, and Mathematics.

Rudd, Horry, & Skains (2020) explored science, technology, engineering, arts, and mathematics.

##### After-school Program

Trott (2020) looked at climate change as an after-school program.

##### Humanities, Arts, Social Studies

Climate change was also imparted in the art and humanities as well as language arts and social studies (Bentz, 2020; Siegner & Stapert, 2020).

##### Professional Development

Likewise, climate change was scrutinized as part of professional development (Sezen-Barrie, Shea, & Borman, 2019).

##### Objective or Purpose of the Study

###### Climate Change and Education

Monroe, Plate, Oxarart, Bowers, and Chaves (2019) identified a growing interest in tackling climate change concerns and performed a systematic review to better understand research and its contribution to successful climate change education. The bicycle model for climate change education was presented and analyzed by Cantell, Tolppanen, Aarnio-Linnanvuori, and Lehtonen (2019). Smith, Besalti, Nation, Feldman, and Laux (2019) explored how computer games may be used to improve climate change teaching and make it more relevant and intelligible. The constraints and potential for climate change education among public and science teachers were recognized by Foss and Ko (2019). Rousell and Cutter-Mackenzie-Knowles (2020) analyzed current research on climate change education for young students from 1993 to 2014, showing that comprehension is limited, erroneous, and heavily affected by media. Before formal classroom instruction, Hestness, McGinnis, and Breslyn (2019) investigated the effect of students' engagement in socio-cultural activities. Bentz (2020) stated that the arts and humanities have a significant impact on climate change and provided a framework for usage in schools.

##### Competencies

Sols-Espallargas and Morón-Monge (2020) presented an innovative teacher education experience and its implications for primary school teachers in terms of sustainability competencies.

##### Teachers

Teachers' arguments on anthropogenic climate change are frequently seen in the media and public discussions, according to Sezen-Barrie, Shea, and Borman (2019). Sezen-Barrie, Miller-Rushing, and Hufnagel (2020) assessed the questions that middle school students had after participating in climate change activities, as well as teachers' reflections on how to improve instruction. Teachers' attempts in adopting climate change lessons associated with next-generation science standards were given by Clark, Sandoval, and Kawasaki (2020). Jones and Davison (2021) studied the range and complexity of climate change teaching's emotional experience.

##### Perspectives

###### Climate Change

Rousell, & Cutter-Mackenzie-Knowles (2020) affirmed that the leading scientist globally agreed with the certainty of

anthropogenic climate change.

### **Climate Change and Critical Education**

According to Reis and Ballinger (2020), climate change is a serious concern in modern society. Education has a critical role in properly interacting with and reacting to these difficulties behaviorally. According to Waldron, Ruane, Oberman, and Morris (2019), carbon emissions from rich nations should be considered in collective action and justice-related educational response. Climate change education must focus on knowledge, skills, motivation, orientation, and emotions (Cantell, Tolppanen, Aarnio-Linnanvuori, & Lehtonen, 2019). Climate change is being taught in K-12 science classrooms, according to Siegner & Stapert (2020). We need social, technological, and scientific answers. Kwauk (2020) noted how the issue necessitates coordinated efforts from official educational institutions, non-formal programs, and informal spaces from primary to post-secondary levels. It also attracts the attention of people from all sectors of society. According to Rudd, Horry, and Skains (2020), the world's climate is fast-changing, and the consequences are becoming obvious in the students' lifetime. The climate system is warming, according to Sezen-Barrie, Miller-Rushing, & Hufnagel (2020), and human conduct is connected to this change. Climate change, according to Jones and Davison (2020), is not only a cognitive but also an emotional encounter in which learning becomes a social reaction.

### **Teaching and Learning Approaches and Strategies**

#### **Artwork, Socio-scientific and Sociocultural**

Support meaning-making develops new images and metaphors and incorporates a broader answer, such as art as communication (Bentz, 2020), as well as an interdisciplinary, socio-scientific approach, are also intended (Siegner, & Stapert, 2020). It was argued that students' contact with media within and outside of their school-based learning experiences – even before official climate change training – appeared to inform their attitudes most significantly about climate change, using socio-cultural theory (Hestness, McGinnis, & Breslyn, 2019).

#### **Inquiry, Collaborative, Participatory, and Active Approach**

Youth-led action projects focused on individual and collaborative change resulted in an after-school program that employed participatory methods, and educational activities with digital photography and concluded in youth-led action projects focused on individual and collective change (Trott, 2020). Positive messages, local impacts, and the utilization of participatory and active learning should be the focus of both formal and informal education (Foss, & Ko, 2019). Monroe, Plate, Oxarart, Bowers, & Chaves (2019) suggested an active and engaging teaching technique that focuses on relevant and meaningful knowledge, allowing for deliberative debate, the correction of misunderstandings, and the implementation of school or community projects.

#### **Multidisciplinary and Interdisciplinary Approach**

Participatory, interdisciplinary, innovative, and affect-driven approaches to climate change education are required (Rousell, & Cutter-Mackenzie-Knowles, 2020). Direct observation, interdisciplinary relationships, future projections inquiries (Sezen-Barrie, Miller-Rushing, &

Hufnagel, 2020), workshops and digital fictions (Rudd, Horry, & Skains, 2020), and integration of cognitive and affective experience may all be prepared and implemented by teachers (Jones, & Davison, 2021).

### **Place-based Approach, Interactive Approach, and Games**

Computer games, web-based science, and hands-on laboratory activities must all be used in a local or place-based approach (Smith, Besalti, Nation, Feldman, & Laux, 2019). Climate change may also be taught through interactive visualizations (Svihla, & Linn, 2012). It is also advised that simpler translation, map reading, graph interpretation, and interactive learning be used (Reis, & Ballinger, 2020).

### **Methodology Employed**

#### **Assessment**

Exam scores and surveys concerning student opinions of climate change science and perceptions of the materials were among the data collected (Smith, Besalti, Nation, Feldman, & Laux, 2019). An electronic questionnaire and documented group discussions were used to conduct the evaluation (Cantell, Tolppanen, Aarnio-Linnanvuori, & Lehtonen, 2019). In the academic database EBSCOhost, 959 unique citation articles related to climate change education were discovered. Only 49 sources met the requirement for focusing on the evaluation of climate change education interventions. Among the information sources were the objective of the intervention, the assessment technique, and methods that may lead to beneficial interventions (Monroe, Plate, Oxarart, Bowers, & Chaves, 2019). The new educational experience involved assessing participants' self-perceptions of their past knowledge of climate change to build a lesson plan (Solís-Espallargas, & Morón-Monge, 2020).

#### **Case Study**

A case study was conducted applying sociocultural theory to examine the climate change ideas communicated by one group of middle school students in a suburban community in the U.S. applying the Climate Science Knowledge Assessment Instrument (CSKAI) (Hestness, McGinnis, & Breslyn, 2019). Student artifacts, teachers' written comments, and semi-structured conversational interviews with teachers provide the data for this multi-case exploratory research. The type of students' wondering queries varied, according to a constant-comparative analysis (Sezen-Barrie, Miller-Rushing, & Hufnagel, 2020).

#### **Literature Review and Textbooks**

Using survey findings and literature from across the world on climate change (Foss, & Ko, 2019). Rousell & Cutter-Mackenzie-Knowles (2020) applied for a systematic literature review. Effective techniques for learning about and engaging with climate change are critical.

#### **Mixed Research and Curriculum**

A semi-structured survey was used to collect data from 24 K-12 teachers in Maryland and Delaware. Although all the participants in our study believe that anthropogenic climate change must be taught, data deductive coding and frequency analysis show that some teachers have climate change denial ideas. Intertextual discourse analysis was also employed in the study to see why teachers are still baffled by the

utilization of sources (Sezen-Barrie, Shea, & Borman, 2019). Student questionnaires, teacher interviews, and classroom observations are the key data gathering and assessment strategies (Siegner, & Stapert, 2020). Students, teachers, and leaders at a high school in New Zealand's Waikato area participated in an interpretative study about climate change and climate change teaching. Online survey focus groups with students and semi-structured interviews with teachers and leaders were used to collect a mix of quantitative and qualitative data (Sharma, 2020). Through an after-school program that employed participatory approaches to encourage children's informed climate change action, this mixed-methods study looked at how ten- to twelve-year-old children experienced and made meaning of climate change knowledge (Trott, 2020).

### **Models and Frameworks**

Although there is a growing consensus that education must adjust to address climate change (Bentz, 2020). The present climate change information and education frameworks were assessed to whether it has a suitable purpose and are capable of supporting successful mitigation and adaptation initiatives (Reis, & Ballinger, 2020).

### **Qualitative Analysis**

This exploratory research examines educators', student teachers', and environmental experts' perspectives on climate change, climate justice, and climate change education using theme analysis of interviews and focuses on group data (Waldron, Ruane, Oberman, & Morris, 2019). A STEAM program encourages students to consider their impact on the environment while also embracing a place in society to effect good social change (Rudd, Horry, & Skains, 2020). Assumptions about the environment in the NGSS affect teaching practice as teachers strive to achieve the standards using three conceptual frameworks. Eight climate-change-related courses were recorded and topically annotated over three years (Clark, Sandoval, & Kawasaki, 2020). In Tasmania, Australia, interviews with young adults were conducted. They had diverse levels of interest in and views on climate change, and they came from various educational backgrounds. Using an interpretivist paradigm, we looked at how participants' feelings about educational encounters with climate change were diverse and interrelated (Jones, & Davison, 2021).

### **Inferences**

#### **Curriculum**

Although aware of local threats, basic climate science, and the need to conserve resources, respondents were prone to climate change misconceptions. Teachers are in favor of teaching climate change, but many mentioned a lack of training, time, money, and climate change's absence from the state curriculum as roadblocks (Foss, & Ko, 2019). Skills are being developed on a larger scale including self-perception and investigative methods used throughout the creative process. These data support the educational proposal as a suitable instructional strategy for long-term scientific curriculum sustainability (Solís-Espallargas, & Morón-Monge, 2020).

#### **Education**

Most environmental education has two similar themes: (1) concentrating on personally relevant and meaningful

knowledge, and (2) employing active and engaging teaching approaches (Monroe, Plate, Oxarart, Bowers, & Chaves, 2019). Participatory, transdisciplinary, creative, and affect-driven strategies are used in climate change education. Climate change education actively engages young people in addressing the scientific, social, ethical, and political concerns posed by climate change (Rousell, & Cutter-Mackenzie-Knowles, 2020). Students exhibited high levels of climate literacy, improved reading comprehension, and general involvement with the issue. Curriculum developers, researchers, and educators must incorporate an interdisciplinary, socio-scientific approach to climate change education (Siegner, & Stapert, 2020). Climate actors may take to not only create a roadmap for the education sector but also create a new set of game-changing rules (Kwauk, 2020). Many international climate change messages are not being received or understood at local levels, underscoring the need for more and simpler science translation. Despite a strong formal education system, there are differences in fundamental abilities such as map reading, and graph interpretation required for basic climate change scientific interpretation. Climate literacy should be attained through interactive long-term learning (Reis, & Ballinger, 2020). In disputes about climate change, facts and emotions collide. Inadequate cognitive and emotional integration in climate change education may result in long-term changes in adult attitudes and behaviors, as well as societal distrust and division (Jones, & Davison, 2021).

### **Lessons and Classes**

The socio-cultural activities of students have implications such as (1) types of informed climate change ideas brought to class; (2) reliable sources of climate change; and (3) problematic and potential connections and perceptions of climate change. Students' climate change understandings from different socio-cultural activities provide a beneficial basis for generating scientific learning experiences that students personally resonate with (Hestness, McGinnis, & Breslyn, 2019). Teachers in classes paid special attention to various tools such as physical and conceptual, norms both epistemic and instructional, emotions, and division of labor routines. Teachers use students' wondering questions to help them identify key aspects of climate change education, such as spatiotemporal thinking (Sezen-Barrie, Miller-Rushing, & Hufnagel, 2020).

### **Textbooks, Teaching, and Learning**

There are two contrasting perspectives on climate change and education. The first is from teachers and students where climate change is a geographical process and the solution is a personal activity. According to the second perspective, climate change is a global injustice that necessitates political, social, and economic mobilization (Waldron, Ruane, Oberman, & Morris, 2019). Students' awareness of sea-level rise and storms was greatly influenced by the type and design of the computer games (Smith, Besalti, Nation, Feldman, & Laux, 2019). The arguments for denial theories are of lower epistemic quality than the rebuttals. Outside of textbooks, teachers looked for the material. However, we find that some academicians are still skeptical of human-caused climate change (Sezen-Barrie, Shea, & Borman, 2019). Art may play a critical role in climate change teaching and involvement in general, providing opportunities for deeper learning and transformational potential in high schools in Portugal. It



gives teachers, facilitators, and researchers a diverse potential of the arts, going beyond preconceptions of art as communication and conventional climate change teaching (Bentz, 2020). Children understood more about the scientific and social aspects of climate change after the program and were inspired by the increasing climate change knowledge. It motivated a sense of empowerment and was eager to learn more and take action to reduce harm (Trott, 2020). Students created their digital fiction to explore the topics from the prior sessions in a context that reflect experiences as well as the themes that arose from the students' original digital fiction (Rudd, Horry, & Skains, 2020).

## Recommendations

### Teaching Climate Change

A critical, open-ended, holistic approach to climate change education is needed, one that provides numerous places for reflection and engages children with citizenship models that include political action. It emphasizes the need for teacher education that helps teachers comprehend the social, economic, and justice dimensions of climate change, as well as their confidence in discussing difficult and political matters in the classroom (Waldron, Ruane, Oberman, & Morris, 2019). This research indicates the potential to leverage standards to create classroom interventions that help diverse students and challenge the assumptions about the human-environment relationship (Clark, Sandoval, & Kawasaki, 2020).

## 5. Results and Discussions

### Learning Area

Climate change is being taught in several subjects and key stages such as science (Smith, Besalti, Nation, Feldman, & Laux, 2019; Foss & Ko, 2019; Hestness, McGinnis, & Breslyn, 2019; and Clark, Sandoval, & Kawasaki, 2020), climate education (Monroe, Plate, Oxarart, Bowers, & Chaves, 2019; Waldron, Ruane, Oberman, & Morris, 2019; Cantell, Tolppanen, Aarnio-Linnanvuori, & Lehtonen, 2019; and Reis & Ballinger, 2020), science, technology, engineering, arts, and mathematics (Rudd, Horry, & Skains, 2020), after-school program (Trott, 2020), art and humanities as well as language arts and social studies (Bentz, 2020; Siegner & Stapert, 2020). It is also part of primary school (Solís-Espallargas & Morón-Monge, 2020), and middle school (Sezen-Barrie, Miller-Rushing, & Hufnagel, 2020) as well as professional development (Sezen-Barrie, Shea, & Borman, 2019).

### Objective or Purpose of the Study

Primarily, the objective and purpose of the study focus on education, competencies in terms of sustainability, and teachers. The objectives include a systematic review of climate change (Monroe, Plate, Oxarart, Bowers, and Chaves, 2019; Rousell & Cutter-Mackenzie-Knowles, 2020), proposing a model (Cantell, Tolppanen, Aarnio-Linnanvuori, & Lehtonen (2019), computer games (Smith, Besalti, Nation, Feldman, & Laux, 2019), and classroom instructions (Sezen-Barrie, Shea, and Borman, 2019; Hestness, McGinnis, and Breslyn, 2019; Bentz, 2020; Sezen-Barrie, Miller-Rushing, and Hufnagel, 2020; Jones and Davison, 2021) and competencies (Sols-Espallargas and Morón-Monge, 2020; Clark, Sandoval, & Kawasaki, 2020).

### Perspectives

This includes the relationship between climate change and critical education. Climate change is anthropogenic (Rousell, & Cutter-Mackenzie-Knowles, 2020; Barrie, Miller-Rushing, & Hufnagel, 2020). It is a serious concern and education has a critical role (Reis and Ballinger, 2020; Siegner & Stapert, 2020; Kwauk, 2020). CCE must focus on knowledge, skills, motivation, orientation, and emotions (Cantell, Tolppanen, Aarnio-Linnanvuori, & Lehtonen, 2019), it is not only cognitive but also an emotional encounter (Davison, 2020).

### Teaching and Learning Approaches and Strategies

The learning approaches and strategies include art as communication (Bentz, 2020), as well as an interdisciplinary, socio-scientific approach, are also intended (Siegner, & Stapert, 2020), and socio-cultural theory (Hestness, McGinnis, & Breslyn, 2019). Participatory methods, and collective change (Trott, 2020), participatory and active learning (Foss, & Ko, 2019), deliberative debate, the correction of misunderstandings, and the implementation of school or community projects (Monroe, Plate, Oxarart, Bowers, & Chaves, 2019). Participatory, interdisciplinary, innovative, and affect-driven approaches (Rousell, & Cutter-Mackenzie-Knowles, 2020). Direct observation, interdisciplinary relationships, and future projections inquiries (Sezen-Barrie, Miller-Rushing, & Hufnagel, 2020), workshops, and digital fiction (Rudd, Horry, & Skains, 2020), and integration of cognitive and affective experience (Jones, & Davison, 2021). Computer games, web-based science, and hands-on laboratory activities in a local or place-based approach (Smith, Besalti, Nation, Feldman, & Laux, 2019), interactive visualizations (Svihla, & Linn, 2012), and simpler translation, map reading, graph interpretation, and interactive learning be used (Reis, & Ballinger, 2020).

### Methodology Employed

The methodology used includes perception (Smith, Besalti, Nation, Feldman, & Laux, 2019), evaluation (Cantell, Tolppanen, Aarnio-Linnanvuori, & Lehtonen, 2019), assessment (Monroe, Plate, Oxarart, Bowers, & Chaves, 2019; Solís-Espallargas, & Morón-Monge, 2020). Case study (Hestness, McGinnis, & Breslyn, 2019) and multi-case exploratory research (Sezen-Barrie, Miller-Rushing, & Hufnagel, 2020). Literature review (Foss, & Ko, 2019; Rousell & Cutter-Mackenzie-Knowles, 2020). Mixed research (Sezen-Barrie, Shea, & Borman, 2019; Siegner, & Stapert, 2020; Trott, 2020). Models and frameworks (Bentz, 2020; Reis, & Ballinger, 2020). While qualitative analysis was also employed (Waldron, Ruane, Oberman, & Morris, 2019; Rudd, Horry, & Skains, 2020; Clark, Sandoval, & Kawasaki, 2020; Jones, & Davison, 2021).

### Inferences

Existing curriculum for climate change (Foss, & Ko, 2019; Solís-Espallargas, & Morón-Monge, 2020). Educational themes approach, and strategies (Monroe, Plate, Oxarart, Bowers, & Chaves, 2019; Rousell, & Cutter-Mackenzie-Knowles, 2020; Siegner, & Stapert, 2020; Kwauk, 2020; Reis, & Ballinger, 2020; Jones, & Davison, 2021). Lessons and classes include sociocultural activities and spatiotemporal thinking (Hestness, McGinnis, & Breslyn, 2019; Sezen-Barrie, Miller-Rushing, & Hufnagel, 2020). Textbooks are pivotal in the teaching and learning of climate

change such as geographical process (Waldron, Ruane, Oberman, & Morris, 2019), computer games (Smith, Besalti, Nation, Feldman, & Laux, 2019), arguments and rebuttals (Sezen-Barrie, Shea, & Borman, 2019) and art (Bentz, 2020). Others include scientific and social aspects (Trott, 2020) and digital fiction (Rudd, Horry, & Skains, 2020).

### Recommendations

Teaching climate change needs a critical, open-ended, holistic approach (Waldron, Ruane, Oberman, & Morris, 2019) and challenges the assumptions about the human-environment relationship (Clark, Sandoval, & Kawasaki, 2020).

### 6. Conclusions

Much of the present literature stressed science as a potent subject for discussing climate change, but others were covered as well, including climate education, arts, primary and middle school, after-school activities, and professional development. A systematic study of climate change, a model, computer games, classroom instructions, and learning capacities were all aims of the review. Teaching and learning approaches and strategies include arts, transdisciplinary, socio-scientific methods, and socio-cultural theory. Participatory approaches include active learning, deliberative discussion, the implementation of school or community projects, as well as inventive and affect-driven tactics. Workshops and digital fiction, cognitive and emotional experience and computer games, web-based science, and hands-on laboratory activities in a local or place-based approach are also included, as are direct observation and future predictions inquiries. Interactive visualizations, simplified translation, map reading, graph interpretation, and interactive learning were among the other approaches used. Perception, evaluation, assessment, case study, and multi-case exploratory research were among the approaches used in the literature. Literature review, mixed research, models and frameworks, and qualitative analysis are all part of the research process. There is already a climate change curriculum, and numerous topics, methods, and solutions have arisen. It might use socio-cultural activities and spatiotemporal thinking in lessons and classes. Textbooks are essential in the teaching and learning of topics such as geography, computer games, arguments and rebuttals, art, scientific and social issues, and digital fiction related to climate change. Recommendations include taking a critical, open-ended, holistic approach to teaching climate change and challenging preconceptions about the human-environment interaction.

### 7. Recommendations

Curriculum framers and policymakers must review the existing curriculum to assess the present integration of climate change education. A systematic integration across learning areas must be supported to ensure sustainable knowledge, skills, attitudes, and behaviors among students. Differentiated instruction in the teaching and learning process must be strengthened using technology and other analytical tools to ensure effective and efficient learning. Community and the school-based project must be advocated to synergize with the various stakeholders and other agencies to truly mitigate and address the problems with climate change. Active involvement of the school in community efforts such as waste management, recycling facilities, and

the likes must be institutionalized ensuring the application of what has been learned in the classrooms. Contextualized study on the status, perception, awareness, beliefs, and practices must be explored.

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