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## CLIMATE CHANGE EDUCATION IN TRANSITION: A CRITICAL REVIEW OF RECENT RESEARCH ON CHINESE CLIMATE CHANGE EDUCATION<sup>1</sup>

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### ABSTRACT

Delivering effective climate change education (CCE) is essential but challenging for countries in the Global South. However, few studies have investigated CCE in developing countries such as China – an important player in global climate change conferences and policies and the world's largest carbon emitter. This study analyzed research published between 2002 and 2024 on the topic of CCE for children and young people in China. To date, the literature on CCE in China has been limited to the formal educational setting of schools, where a top-down, science-based approach to CCE prevails. Schoolteachers focus on presenting climate-change-related knowledge and developing corresponding curricula and resources. At the same time, innovative bottom-up approaches are beginning to emerge. However, the literature has largely failed to explore diversity in CCE. This review highlights the need for educators to develop participatory, interdisciplinary, creative and affect-driven approaches to CCE in China.

*Keywords: Chinese climate change education, Systematic review, Participation, Creativity*

### INTRODUCTION

Climate change is widely regarded as the greatest challenge that humankind has ever faced. Every report issued by the Intergovernmental Panel on Climate Change (IPCC) has confirmed that climate change is real and that human activities are the main cause (IPCC, 2001, 2007, 2014, 2023). The social, cultural and environmental impacts of climate change are beginning to permeate the daily lives of children and young people, who are growing up in an era of uncertainty and instability (Lee, 2013) and face the consequences – many as yet undetermined – of climate change caused by previous generations.

Issues related to climate change are spreading rapidly through a variety of new media channels and have become hot topics in many countries. Whether through direct experience, through media channels or at school, children and young people are regularly confronted with issues related to global warming. Moralizing and politicizing rhetoric around climate change, as well as rhetoric that questions or even denies the scientific

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evidence for climate change has played a significant role in delaying efforts to address climate change (Sassan et al., 2023). Through communication channels such as social media, movies and television, children and young people are increasingly exposed to textual and visual depictions of the catastrophic consequences of climate change (Colebrook, 2014). Large numbers of children are forcibly displaced by weather-related disasters every year (UNICEF, 2023). Controversies around climate change are intertwined with perceptions of and concerns about the phenomenon of climate change itself. As a result, climate change is exerting an increasingly negative influence on the social lives of young people (Ojala, 2012). Research has shown that young people are experiencing growing pessimism and hopelessness about climate change and the future in general (Ojala, 2012).

Children and adolescents are the future leaders of society; they are the stakeholders in and future decision makers on climate change and are expected to contribute significantly to climate change mitigation and adaptation (Lee, 2013). Although children and young people are passionate and creative, they currently have limited opportunities to develop and express their understanding of and concerns about climate change in their local environments and communities (Rousell & Cutter-Mackenzie-Knowles, 2019). Climate change education (CCE) has emerged as an important means of promoting awareness of climate change. However, CCE is still a newer and less theorized field of study than related fields such as science education and environmental education (Eilam, 2022). A global questionnaire on youth and climate education administered by UNESCO (2022) revealed that young people are dissatisfied with the current provision of CCE. Children and young people need innovative, effective and high-quality forms of CCE.

Providing such CCE is a challenging yet essential task for the Global South (Ma & Chen, 2023). However, literature has paid insufficient attention to CCE in these regions. Particularly lacking is a systematic compilation and summary of the Chinese-language literature on CCE in China. Rousell and Cutter-Mackenzie-Knowles (2019) analyzed international literature on CCE published between 1993 and 2014 and found that this research had a wide geographic scope, with the largest number of CCE studies conducted in the United States and considerably fewer in Asia and South America. Research on CCE in China has usually been conducted by European researchers and published in English-language journals (Sternäng & Lundholm, 2012).

As a large developing country with a huge population, China positions education, public awareness and public participation as key strategies for addressing climate change. The government has published national reports in a series entitled China's Policies and Actions to Address Climate Change since 2008. Education is one of the key strategies deployed by China to address climate change as an important tool for promoting ecological civilisation and achieving high-quality development. China's National Plan for Addressing Climate Change (2014–2020) clearly highlights the need to strengthen education and training. Integrate climate change education into the national education system, promote climate change knowledge in schools and classrooms, and popularize scientific knowledge on climate change (NDRC, 2014). In 2021, a white paper entitled China's Policies and Measures to Address Climate Change was published.



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In the context of the government's implementation of a national strategy to actively address climate change, how has CCE in China developed? The present study seeks to answer this question based on analysis of Chinese-language research on CCE. Chinese scholars' increasing interest in CCE provides an opportunity to conduct a systematic review to understand the current status of CCE in China.

## **METHODS**

This paper analyzes studies of CCE in China published in Chinese between 2002 and 2024 to understand the current state of CCE research in China, identify trends and innovations emerging from the literature, and inform creative approaches to CCE. To achieve these goals, a systematic analysis of 330 journal articles was conducted to capture the distribution and types of Chinese-language research on CCE, focusing on a variety of educational contexts, disciplines and approaches to innovative CCE for children and young people. The first part of this paper describes the methodology used to conduct systematic literature review, including the rationale for including particular studies. The second section outlines and analyzes the findings of the review, using diagrams to illustrate the educational settings, focal disciplines and other aspects of CCE research in China. The paper concludes by recommending that creative, participatory and technology-mediated approaches be implemented to empower children and young people to engage with climate change issues in culturally and regionally relevant ways and help them address the complex impacts of climate change on their communities and environments.

On April 3, 2025, the authors searched the China Knowledge Network ([www.cnki.net](http://www.cnki.net)) database using the keywords “气候” and “教育” and scanned 3,024 search results, initially identifying 385 publications for inclusion in the review. Fifty-five publications that were not directly relevant to CCE were removed, ultimately reducing the number analyzed to 330. These papers were published from 2002 to 2024. The context of CCE is the complex web of everyday life; it is not confined to the classroom in formal educational settings (Stephens & Graham, 2008; Nche, Achunike & Okoli, 2019). Therefore, learning about climate change should take into account a wide range of environmental influences, including parents, teachers, media, communities and institutions. To provide such flexibility, this review included studies conducted in both formal and informal educational settings, including school education, community-based programs, programs run by museums and teacher training programs at universities.

Four key aspects of the 330 selected publications were analyzed: (1) the date of the study; (2) the educational setting in which the study was conducted, namely kindergarten, primary school, secondary school, university or another educational setting; (3) the disciplinary basis of the study; and (4) the approach to CCE used or advocated in the study.



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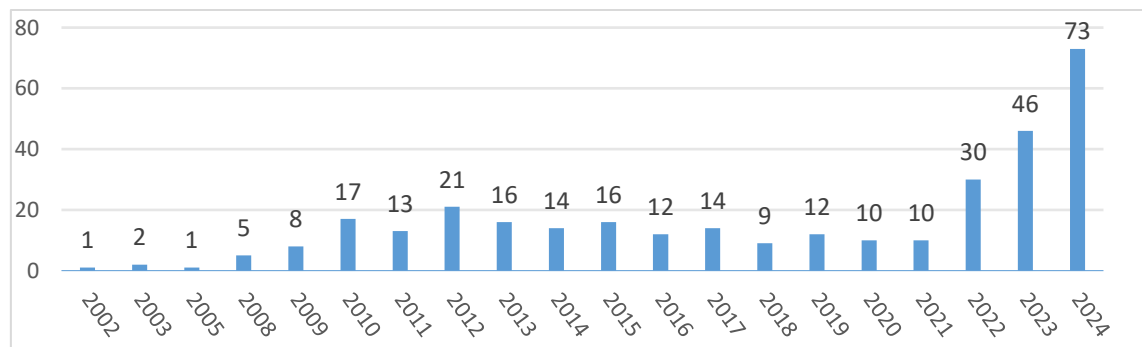
### FINDINGS

#### Chronology

To determine the chronology of CCE research, the publication date of each study was tracked (see Figure 1). The earliest Chinese-language paper on CCE found was that of Jia (2002), which demonstrated the role of case teaching in cultivating innovative talents through the application and exploration of case teaching of meteorology and climatology. Liu (2003) also published a paper on the reform of meteorology and climatology courses for geography majors in higher teacher training, arguing that teachers should reform the content taught; help students to understand the boundaries of the discipline and cultivate their scientific research and social service skills; and make full use of maps and multimedia to support teaching.

Figure 1

*Chinese-Language Publications On Climate Change Education by Year.*



The findings of this review suggest that no scholars in China investigated CCE during the 20th century, and that prior to 2008 only four Chinese-language research papers on CCE in China were published. However, there has been a significant increase in the number of such papers since 2008, which coincides with the rapid development of the field of CCE outside the United States, Canada and Europe (Rousell & Cutter-Mackenzie-Knowles, 2019). Interestingly, the review also revealed a slight decrease in the number of CCE studies published between 2013 and 2021. The number of relevant papers published increased sharply in 2022, when three times as many papers on this topic were published as in the previous year.

#### Contextual Focus

The second key aspect of the studies analyzed was the context of CCE (see Figure 2). In the literature related to primary and secondary education, knowledge-based approaches to science education were most frequently discussed, with the emergence of interdisciplinary voices that encourage student participation. In higher education settings, studies were more likely to discuss participatory and experiential approaches to CCE. Studies of informal education scenarios, such as museums and communities, emphasized that CCE seeks to stimulate learners' interest through immersive learning environments.

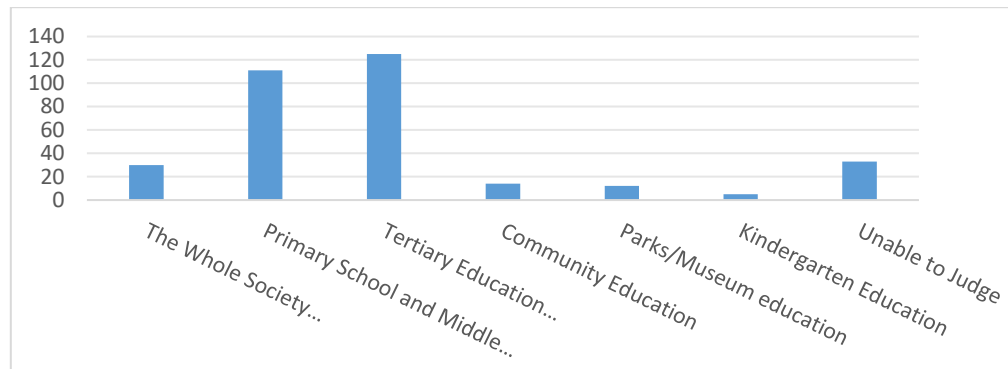


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Figure 2

*Contextual Focus of Research on Chinese Climate Change Education.*



Schools are the main places in which students engage in learning activities. According to CCE studies focusing on the kindergarten, primary and secondary school stages, nurturing scientific knowledge of climate change is the core goal of climate change teaching and learning. These studies have argued that scientific knowledge of climate change and environmental protection should be included in compulsory courses at the primary and secondary school levels (Zhai, 2015). Some articles have explored CCE from the perspective of science education and argued that improving climate science knowledge is an important goal of CCE. However, although some scholars have pointed out that cultivating climate science knowledge is the foundation of CCE, they have also claimed that the concept of education needs to be changed (Wang & Chen, 2021). In addition to knowledge acquisition, an important goal of CCE is to change students' behaviors and attitudes through education and help them make correct decisions in the face of climate-change-related problems (Li Hu et al., 2022). CCE should seek to help students recognize and understand climate change, leading to changes in their attitudes and behavior, and acquire the ability to respond positively to climate change (Fang & Zeng, 2014). The views of the above scholars suggest that CCE in China is undergoing a conceptual shift. Practitioners and researchers in China began to realize that CCE is not only about raising awareness, but also about changing attitudes and behaviour and empowering learners.

In primary and secondary education in China, some subjects, such as geography, are considered to have a direct link to CCE. The geography curriculum at general high schools in China includes a clear teaching standard regarding climate change: "Based on relevant information, explain the impact of global climate change on human activities". As a result, geography is recognized as an important way to implement CCE in China (Fang & Zeng, 2014). However, CCE involves a wide range of components, and the implementation of CCE in primary and secondary education requires multidisciplinary integration. Some researchers have focused on integrating climate change knowledge into other disciplines, such as chemistry and art (Tao, 2011; Fei, 2012). Some scholars have argued that to cultivate students' multidisciplinary core literacy, interdisciplinary thematic learning activities that integrate science, technology, engineering, mathematics, and the arts and humanities should be implemented from the kindergarten stage to the primary and junior high school stages (Dai, 2023).



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Compared with primary and secondary education, higher education has a greater presence in CCE research, because more innovative and experiential teaching methods are developed in higher education. Huang (2005) pointed to the need to integrate multimedia technology into meteorological education and explored the “JLHD teaching and learning model”, which adopts a psychological viewpoint to break down teaching and learning in the multimedia meteorological climate classroom into six components: motivation expectation, understanding and perception, acquiring information, storing memory, tracing memory, and generalizing and summarizing. In 2009, a survey on college students’ awareness of climate change conducted by Pan et al. revealed that even students in the field of agriculture lacked an adequate understanding of the pathways of greenhouse gases and how they are related to climate change (Pan). The authors concluded that there is an urgent need to strengthen CCE at the undergraduate level in colleges of agriculture and recommended introducing a public elective course on climate change and response or a specialized course on climate change management.

In CCE in colleges and universities, the project-based teaching method or the flipped classroom approach is used to switch the role of students from passive learners to research leaders and agents in interpreting research and taking actions. These methods not only enhance the outcomes of carbon emission reduction education but also cultivate students’ sense of social responsibility (Wang et al., 2022; Zhong & Xue, 2024). The School of Life Sciences of Capital Normal University is also working to promote CCE in primary and middle schools. The School has established a long-term and effective CCE model for the whole of society through social practices such as research on green agriculture, dissemination of extreme weather response methods, and promotion of climate change education in primary and secondary schools (Tang & Wang, 2024).

CCE cannot be achieved through classroom teaching alone; educating people about climate change needs to take place in a broader societal context, such as through different types of learning activities delivered in botanical gardens, zoos, nature reserves, museums and nature education centers. Parks and other “nature-based” spaces are seen as important places for the public to experience and learn about climate change (Brownlee, Powell, & Hallo, 2013). As a form of public education, CCE in the above scenarios is resilient and can go beyond mere knowledge transfer to engage the senses and creativity.

In China, museums are becoming important venues for public participation in climate change. Through interactive media and immersive learning environments, museums are stimulating the interest and curiosity of visitors through interactive presentations and entertaining formats. China’s museum practitioners are actively discussing how to integrate into local communities, promote regional economic and cultural development, and take on various social responsibilities (Xie & Yang, 2023).

Parks are also places where people can make personal connections with climate change issues. Wang et al. (2018) argued that park trail tours should fulfill the function of environmental education and the design of garden facilities should incorporate environmental protection principles to achieve greater public participation in urban parks. However, the function of China’s urban parks as an important carrier of environmental education is still far from being realized, and environmental knowledge, ecological concepts, and environmental science and engineering technologies have not been well integrated into the landscape design of urban parks.



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Community education has also been identified as a priority area for CCE research. Most CCE activities carried out in Chinese communities are based on the theme of carbon reduction, with science lectures and tree adoption as the main points of focus (Niu, 2023). The “Carbon Footprint Study” program in Shuangxiu Community Park in Beijing provided participants with concrete ways to implement carbon reduction in their own families and communities, such as family discussions, publicity in the park with self-designed posters, and distribution of brochures on energy saving and emission reduction. The results showed that the program greatly improved the participants’ awareness of dual-carbon goals. They engaged in relevant communication with their family members during the course, exhibited obvious daily carbon reduction behaviors, and urged their family members to change their lifestyles. These behaviors were sustained after the end of the course (Niu, 2023).

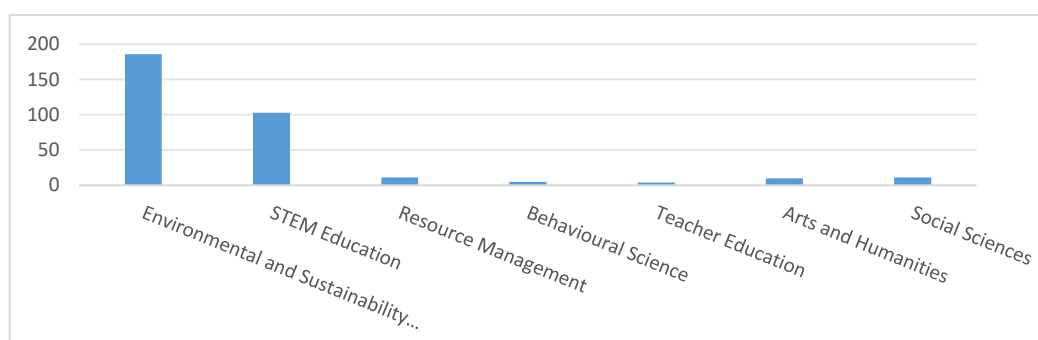
### Contextual Focus

The third aspect of studies of CCE analyzed in this review was the subject area associated with each CCE paper (see Figure 3). Seven subject areas were identified, but the majority of the literature focused on the field of education and teaching, specifically related to environmental and sustainability education in primary and secondary schools and science, technology, engineering and mathematics (STEM) education.

The following sections discuss these two main disciplinary areas in depth, before briefly describing the other five subcategories, namely resource management, teacher education, behavioral science, the social sciences, the arts and the humanities.

Figure 3

*Disciplines Associated with Chinese Climate Change Education Research*



In the field of education, CCE is concerned with improving teachers’ and students’ knowledge of climate change and with researching teaching strategies and methods. Practitioners have proposed a variety of strategies to increase teachers’ and students’ scientific knowledge, including integrating curriculum content, updating teaching methods and creating hands-on learning environments. The literature on teacher education is relatively limited. Most research on teacher education has focused on improving pre-service teachers’ knowledge of climate change and related innovations in teaching techniques. Gao and Li (2018) found that the status of pre-service teachers’ CCE is poor. The China Association for the Promotion of International Cooperation among Civil Society Organizations launched the China Climate Change Education Project in 2012,



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which involves organizing teacher training as one of a series of activities focusing on the dissemination of climate change knowledge (Gao & Li, 2018). Tang and Wang (2024) pointed out that in addition to facilitating classroom learning, teacher training colleges can encourage college students to form science and technology volunteer service teams, which can play a role in CCE by connecting with the wider society through social practice.

Countries across the world, such as the United States, the United Kingdom and Australia, have implemented CCE and reported valuable outcomes and experiences. Many Chinese scholars have sought to thoroughly analyze other countries' practices and experiences of CCE to provide a reference and implications for CCE in China (Yang, 2009; Zhang, 2011; Feng, 2022; Yu, 2022).

Disciplines related to resource management were also mentioned in a number of the reviewed publications. A number of papers in the fields of museum studies, forestry, and local governance focused on CCE, with attention to adaptation and mitigation initiatives within local communities, museums and parks. Museums and parks are in a unique position to design and deliver informal education to the public. Museums are beginning to use their own resources for climate change education and mitigation, as well as research programs. As climate change makes biodiversity conservation more difficult, parks and other protected areas are assuming a social role, including the provision of CCE programs in the surrounding community and the use of various means to popularize science.

CCE is particularly important for climate-vulnerable regions in China, such as Tibet and Xinjiang, due to their specific geographical and climatic conditions. Ping, C. et al. (2014) called for the rapid rectification of the backward situation of environmental education in Tibet. Li and Wang (2023) analyzed how farmers in Jimusar County, Xinjiang, China face climate risks directly caused by drought. They recommended introducing financial subsidies for farmers, strengthening training in farmers' resilience to climate risks, and encouraging experienced farmers to take the lead in enhancing people's adaptive capacity to cope with climate disasters (Li & Wang, 2023).

Social sciences have also been mobilized in the field of CCE research. Social survey methods have been widely used to investigate climate change awareness among youth and university students (Pan et al., 2009; Zhai, 2015). Psychological approaches have been used to design teaching methods for climate change curricula, as well as to build the climate adaptive capacity of individuals and communities, especially in addressing barriers to and motivations for environmental behavior change and enhancing the resilience and coping strategies of individuals and communities to address the threat of climate change (Li & Wang, 2023).

Huang (2005) analyzed teaching and learning in a multimedia climate classroom from a psychological perspective, focusing on perception, comprehension and memory. A survey on climate change and environmental awareness among Chinese youth found that the level of understanding of climate-related terms among Chinese youth was below 50% and the level of familiarity with related terms was only about 10% (Zhai, 2015). However, more than 80% of the surveyed students believed that their own behavior had an impact on climate change, and more than 80% of the students were willing to respond to climate change through "daily behaviors such as saving water, electricity and energy" (Zhai, 2015). Pan et al. (2009) investigated the climate change awareness of students at Nanjing



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Agricultural University and found that the surveyed college students did not have sufficient knowledge of greenhouse gases or their relationship with climate change and lacked a high level of awareness of climate change and motivation to reduce emissions. Delivering effective CCE has become an urgent task for Chinese university educators (Zhou & Zhang, 2016).

Artistic works have the potential to directly stimulate emotional and somatic responses to the topic of climate change, allowing people to develop emotional experiences and new perceptions of climate change, which in turn can bring about changes in their attitudes and behavior (Duxbury, 2010). Through analysis of the social and cultural factors that underpin the public representation of these issues, the humanities make a specific contribution to the public debate on climate change (Braidotti, 2013). However, few publications in Chinese have directly addressed the role of the arts and humanities in CCE. In art education research, some scholars have recommended integrating environmental education into art teaching (Song, 2015). According to Jiang and Tao (2014), many myths and legends passed down from ancient China to the present day, such as Kuafu chasing the sun, Houyi shooting the sun and Dayu ruling the water, contain meteorological knowledge; therefore, such myths and legends, with which students are usually familiar, can be used to foster students' atmospheric science knowledge. Historical records and stories can be discussed alongside meteorological principles from the perspective of inquiry, leading to participatory meteorological science liberal arts education (Jiang & Tao, 2014). While many Chinese educational practitioners in the arts and humanities engage in and contribute to climate action through practices such as climate change poster design workshops and art public service exhibitions, this potential remains a relatively untapped resource in the Chinese-language literature on CCE.

In 2023, Liu Kui and Chen Pingping translated Svarstad's article *Critical climate education: studying climate justice in time and space* to advocate for climate education in China to enhance students' insight into and ability to make effective climate mitigation choices (Svarstad, 2021). This article and its translation recommended that students bring their knowledge and experiences from the social realities of everyday life into the classroom and develop a critical understanding of those realities through dialogue with other students and teachers. Critical climate education aims to provide students with the knowledge and skills necessary to act responsibly in response to the climate crisis (Svarstad, 2021). The emergence of this Chinese translation indicates that Chinese scholars are beginning to pay attention to the socio-cultural and ethical dimensions of climate change in the field of CCE.

### Educational Approaches

Teaching methods currently used in Chinese schools to address climate change include classroom lectures, group discussions, social activities, scientific experiments and program design (Li Hu et al., 2022). The design of CCE is mostly based on inquiry-based or cooperative group learning. Teachers have introduced a variety of new teaching methods into the classroom, such as the WebQuest teaching model, the geographical thinking model and case-based learning. It has also been emphasized that the implementation of CCE in basic education requires multidisciplinary cooperation (Fang &



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Zeng, 2014). To improve teachers' climate change teaching ability, methods include conducting advanced classes for teacher training and organizing activities such as CCE competitions, CCE media salons, policy dialogues and international exchanges on CCE (Yang, 2018).

Cross-regional, cross-school and cross-classroom CCE projects and social practice activities for young people have also emerged as methods of delivering innovative CCE. China currently has a number of model multi-stakeholder CCE projects. For example, the Department of Ecology and Environment of Jiangsu Province, in cooperation with other government departments, led the first set of "Low Carbon Life, Green Development" social practice activities for youth, with primary and secondary schools as the core and the government and third-party environmental protection agencies or organizations as the multi-principal synergistic promotion mechanism. They collected 10,180 entries from young people in 13 municipalities across the province (Li Hu et al., 2022). Jiangsu Yueya Lake Nature School was established in Yueya Lake Park in 2018 by the Qinhuai District Environmental Protection Bureau in cooperation with the Jiangsu Provincial Environmental Protection Education Center. Yueya Lake Nature School is a national nature education pilot project in China, which focuses on providing effective and comprehensive management of the water environment of Yueya Lake and pursuing theoretical development and practical innovation in nature education (Yan, 2019). Some projects are initiated by social organizations to promote climate education through communication and training. Communication is crucial to connect professionals, practitioners and learners in the context of CCE, usually in the form of training, conferences or practical information sharing. In 2021, for example, the China Association for the Promotion of International Cooperation among Civil Society Organizations launched the China Climate Change Education Project, which mobilizes learners' motivation and actions through a series of means and activities, such as the development of teaching materials, teacher training, policy advocacy, climate change creativity competitions in schools, scenario simulations and environmental mini-games (Yang, 2018)

The Internet, digital technology, and artificial intelligence (AI) technology offer channels for innovative and empowering forms of CCE (Wu et al., 2023; Chen, 2019, Fu, 2024). Chen (2019) discussed how Chinese teachers can use international scientific websites or educational websites (such as PBS Learning Media and UNESCO's TLSF program website) to develop teaching resources in geography education. This can help teachers eliminate outdated teaching materials and improve their instructional design. Fu (2024) used ChatGPT in the instructional design of the course Global Climate Change and National Security, and found both opportunities and challenges. Challenges included changes to teachers' roles and their diminished status. While students' independent learning was promoted, they had fewer collective learning opportunities, and while ChatGPT provided opportunities for efficient knowledge acquisition, it also increased the risk of errors.

The above approaches have a similar focus on reducing the negative impact of human activities on the climate and reducing the negative impact of climate change on human and natural systems. Mitigation actions aim to reduce human beings' contribution to climate change, while adaptation actions aim to build the adaptive capacity and reduce the vulnerability of individuals, communities and environments in the face of changing



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climate conditions (Anderson, 2012). About a quarter of the literature on CCE in China refers to mitigation and adaptation approaches, which are often associated with community education and local governance. Adaptation approaches are less frequently mentioned and usually appear alongside mitigation approaches.

This review revealed that the Chinese-language literature on CCE to date has generally examined top-down approaches in which educators are orientated toward the target audience. However, a number of innovative bottom-up approaches have begun to emerge within this top-down model of education. These include participatory and experiential approaches aimed at stimulating the autonomy of the target audience, such as participatory weather observation activities (Yang et al., 2022). Participatory and experiential teaching is flexible and diversified based on students' interests, with the inclusion of discussions and debates to enable students to deepen their knowledge (Zheng, 2022).

The application of indigenous knowledge such as Chinese festivals and ancient Chinese myths and legends in the field of CCE is also a relatively new direction in research (Jiang & Tao, 2014; Xu et al., 2023). However, few related studies were found in this review.

## **CONCLUSIONS**

Through a systematic review of the literature on CCE published in Chinese, this study attempted to map the current state of the field and predict the direction of future development. The findings revealed that in the last two decades, the number of studies in the field has been relatively large and their content has been rich, covering a variety of contexts, disciplines and pedagogical approaches.

However, the diversity of research on CCE in China is still limited. Top-down, science-based approaches in formal educational settings remain dominant in CCE provision, with teachers focusing on teaching climate change knowledge in schools and developing curricula and resources. Although CCE has been incorporated into the curricula of some schools, it is mostly included as a learning unit in curricula on "global change"; no specific CCE program has been developed to date. CCE in Chinese schools is usually delivered as a component of the geography subject and relevant knowledge is mostly transmitted through lectures, with low levels of student participation and limited outcomes (Yu et al., 2022). CCE in China lags behind the fundamental requirements of national action to address climate change. Although the implementation of CCE is gradually increasing in informal education settings, the number of related studies is still relatively small.

Since 2008, there has been a significant increase in the number of papers on CCE in Chinese, which coincides with the rapid growth of CCE outside the US, Canada and Europe (Rousell & Cutter-Mackenzie-Knowles, 2019). Since 2008, the Chinese government has released successive national reports entitled China's Policies and Actions to Address Climate Change, which demonstrates the role of the state as a driving force in China's climate-change-related sectors. This is also reflected in the number of papers published on climate change education and research.



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In a cross-national report on CCE, Læssøe, J. et al. (2009) identified three possible scenarios for the global diffusion of CCE: CCE will develop independently of education for sustainable development (ESD) and wider environmental education and become an important part of science education programs; CCE will develop as an important part of ESD; and CCE will become a separate field of practice and inquiry, both linked to and distinct from other branches of ESD and environmental education. The trajectory of CCE in China falls into the first category. An analysis of the literature on CCE in Chinese reveals that CCE is currently becoming an important part of science education programs in China, and it has not developed independently of ESD or broader environmental education but exists as an important component of science education as well as environmental education.

Multidisciplinary, participatory and creative approaches are needed to differentiate CCE from science and environmental education. Educators in many disciplines in China are interested in delivering CCE. Collaborative, interdisciplinary, participatory, place-based and experiential learning programs can have a significant impact on children's and youth's attitudes toward and actions in response to climate change. How to create participatory opportunities for learners has received attention from Chinese climate change educators, but there are still shortcomings in the exploration and adoption of creative approaches. At the same time, closer examination of relevant studies reveals that the ultimate aim of collaborative, interdisciplinary and participatory approaches to CCE in much of the Chinese-language literature is still to promote knowledge-based CCE.

The scientific, social, ethical and political complexity of climate change calls for participatory and creative approaches to education that see children and young people as collaborators; that directly engage children and young people as agents of change in their communities; and that enable children and young people to participate in the inter-temporal entanglement of values, power and concerns that characterizes climate issues. Climate change educators should use the unique perspectives and experiences of children and young people to provide new frameworks for and approaches to teaching and learning about climate change. This will involve the development of new models of CCE based on innovative research and practice in individual countries and linked with related disciplines such as digital innovation, citizen science and the creative arts. Chinese academics are open to exploring CCE overseas; for example, in 2003, Hua (2003) introduced Australia's experience of environmental education to China and reflected on its implications. As of April 2024, a total of 28 papers had been presented on foreign practices and research on CCE. Some scholars have even translated relevant overseas papers into Chinese to inform Chinese scholars and practitioners (Svarstad, 2021).

To date, the literature on CCE in China has mainly focused on schools as formal education settings, with less attention paid to informal settings such as parks and museums and no studies analyzing informal settings such as zoos and oceanariums. Some scholars have sought to develop Web-based climate education resources for schools (Chen, 2019), but no studies appear to have utilized gamification or used various interactive means to engage the public in climate change scenarios and actions.

Chinese scholars in many disciplines, such as the arts and humanities, have so far shown little interest in the topic of CCE. In the field of CCE in China, much of the current practice and research focuses on how to stimulate deeper learning and action based on



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climate change knowledge. However, few activities promote reflective thinking and the development of critical thinking skills, and there is a lack of opportunities for learners to be exposed to and learn about a wide range of perspectives. Regrettably, the publication of the Chinese translation of Svarstad's (2021) article *Critical climate education: studying climate justice in time and space* in April 2023 did not generate further relevant discussion in areas such as education research in China. Data from the China Knowledge Network show that as of 5 May 2024, the article has been downloaded only 138 times and has never been cited.

To enhance students' knowledge and understanding of climate change issues in a more holistic way, CCE in China should encourage students to explore and develop their own understanding of climate change with a sound scientific basis and awareness of a wide range of societal perspectives. This process of exploration not only helps students to critically examine what they have learned but also encourages them to courageously defend their own views and to broaden and deepen their understanding in their interactions with others. Through this process, students will gain a deeper understanding of the science and complexity of climate change, as well as the logic and rationale behind different perspectives. They will also gain greater confidence in what they know and feel, enabling them to make more informed and responsible decisions in the face of the global challenge of climate change.

This study focused only on publicly available peer-reviewed academic papers; it did not include doctoral or master's theses published in Chinese, relevant newspaper articles, or research reports. Therefore, it has some limitations in presenting the current state of research on CCE in China. To address these limitations, future research should also draw data from the above-mentioned sources.

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