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Exploring the landscape of climate change education in China: trends, knowledge, attitudes and behaviours among university students and teachers

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Abstract

Purpose – This study aims to investigate climate change education (CCE), including global trends and specific implementations in China, as well as the worldwide development of CCE and its key components, including knowledge, attitudes and behavioural patterns.

Design/methodology/approach – The authors combined bibliometric analyses and a targeted questionnaire based on the knowledge–attitude–practise (KAP) model to investigate CCE. Initial global trends identified through VOSviewer guided the study survey, focusing on Chinese university students and educators' knowledge, attitudes and practices.

Findings – The high level of concern about climate change among Chinese students and educators and their actual understanding of this issue often results in overconfident self-assessment. Academic specialisation significantly influences the level of climate change concern, with humanities and social sciences students and educators demonstrating higher concern than their counterparts in the natural sciences. The study highlights the essential role of effective climate policy dissemination in shaping informed attitudes and behaviours, particularly in a government-driven policy landscape like China's. Climate policy awareness, positive emotions, self-efficacy, collective efficacy and personal experiences all positively impact Chinese youths' climate change engagement. CCE is primarily delivered uniformly across China through policy instructions and specific courses, yet more engaging, interactive and localised educational approaches to CCE that are tailored to regional and cultural contexts are needed.

Originality/value – Combining bibliometric analysis with survey data, this research uniquely highlights the significance of the political context in China, emphasising the critical role of policy dissemination in shaping climate change perceptions and actions, addressing regional differences and the local context. Based on the KAP model, the study proposed a new model for implementing CCE in collectivist societies like China.

Keywords Bibliometric analysis, Climate change education, Environmental education, VOSviewer, China

Paper type Research paper

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1. Introduction

Over the past decades, China has confronted significant challenges related to global climate change (GCC). Accelerated urbanisation and escalating global temperatures have intensified the severity of urban heat waves and increased public health risks. In 2022, the average surface temperature in China was 0.92°C above normal, making it one of the three warmest years since the early 20th century. In response, China has progressively incorporated climate change education (CCE) into its education system. CCE focuses on creative learning, critical thinking and capacity building, equipping youth with the necessary skills to access information and undertake measures (Stevenson *et al.*, 2017). China's commitment to CCE is evident through various initiatives and policies aimed at embedding climate education within its schooling system. Notable initiatives include the "green school" launched in 1996 under the National Environmental Publicity and Education Action Programme (Wiedenbach, 2020). In 2014, the government proposed a more comprehensive integration of CCE into the national curriculum.

Despite these efforts, the implementation of CCE encounters significant challenges, including monotonous educational content, insufficient academic research, and large regional differences. While economically developed regions are more capable and committed to implementing CCE, less developed areas lack incentives and resources (Han, 2015). These shortcomings hinder the effectiveness of CCE and negatively impact the attitudes and behaviours of students and teachers towards GCC. The current approach to CCE in China is characterised by political publicity and top-down teaching, with scant regard for content, form and pedagogical strategies. Although CCE is integrated into compulsory subjects like geography and chemistry, the teaching often lacks depth and remains utilitarian, focused more on achieving high academic grades than on fostering a genuine understanding or commitment to solving global warming (Hung, 2023). Recent studies warn that universities fall short of providing comprehensive and accessible climate change research, which is crucial for developing a nuanced understanding of complex environmental issues (Leichenko and O'Brien, 2020; Patlins *et al.*, 2020). This deficiency can be attributed to socioeconomically driven educational policies without arrangements, coordination, and evaluation (Han, 2015).

To better understand and enhance CCE in China, this study uses the knowledge–attitude–practise (KAP) model, a widely used survey tool in social research. This model posits that effective education should enhance knowledge, positively influence attitudes and encourage practical engagement. In the context of climate change, the KAP model aids in understanding how improved knowledge of climate change impacts attitudes and subsequent behaviours. University students and teachers are pivotal to the success of CCE (Reimers, 2021; Putri *et al.*, 2022). Through a combination of quantitative and qualitative analyses, this study investigates the following core questions:

RQ1. What are CCE research trends, main contributors and focal points?

RQ2. What knowledge do young Chinese people hold regarding climate?

RQ3. How do demographic factors and knowledge of climate change influence the level of concern among university students and teachers?

RQ4. What attitudes towards climate change are prevalent among Chinese university students and teachers, and how do they correlate with their knowledge of climate change?

RQ5. What factors, including attitudes, influence Chinese university students' and teachers' participation in climate-related activities?

RQ6. What are the regional disparities in implementing CCE across China?

RQ7. What are the expectations and preferences of students and educators regarding the future implementation of CCE?

2. Literature review

2.1 The relationship between knowledge, attitudes and action related to climate change

The KAP model posits that knowledge about an issue influences attitudes, which shape practices or behaviours. Nonetheless, numerous studies indicate that misconceptions about climate change prevail among students and teachers, suggesting a failure of current education to generate sufficient impact on students' knowledge of climate change. For example, Milovanovic *et al.* (2022) evaluated climate science knowledge among 4,364 undergraduate engineering students in the USA, revealing that merely 30% of the students grasped the causes and solutions. Teachers, often regarded as the most trusted sources of climate information, often lack adequate training and knowledge (McGinnis *et al.*, 2017).

While Guy *et al.* (2014) found a correlation between high-level climate knowledge and heightened climate concerns, other frameworks suggest that climate literacy does not necessarily translate into pro-environmental attitudes or behaviours (Kollmuss and Agyeman, 2002; Kolenatý *et al.*, 2022). This knowledge–action gap illustrates the intricate interplay of various factors, including demographic influences, that shape concerns about climate change. According to the value–belief–norm theory, individuals are more likely to adopt environmentally friendly behaviours if they perceive climate change as a threat and believe that their actions can mitigate its effects (Stern *et al.*, 1999). Regional variations play a critical role in this dynamic; for example, students in eastern and southern Taiwan, where extreme weather events are more prevalent, tend to express greater concern about climate change (Di Giusto, 2018). Additionally, an individual's field of study can also influence his or her values and behaviours, as shown in recent studies (Leal Filho *et al.*, 2023; Sasa *et al.*, 2023).

2.2 Social identity theory

The social identity theory (SIT) is a prominent concept in social psychology that has garnered considerable attention in recent decades. Initially proposed by Henri Tajfel in the 1970s, SIT was further developed through the self-categorisation theory by Tajfel and John Turner. Tajfel (1978) defined social identity as "part of an individual's self-concept which derives from his knowledge of his membership of a social group together with the value and emotional significance attached to that membership". According to SIT, individuals are more likely to engage in pro-social behaviours when they identify with a group that endorses such behaviours, as this enhances their sense of belonging and self-esteem. Therefore, social identity is a psychological mechanism in which individuals perceive themselves as members of a social group and, based on this identity, determine their behaviours, attitudes, and values.

This mechanism plays a crucial role in understanding how climate change mitigation actions can be influenced in collectivist societies. Social identities shape responses to climate change through processes like group norms, collective efficacy and emotions (Masson and Immo, 2021; Bamberg *et al.*, 2015). Partisan identities often hinder climate policy adoption, particularly in fossil fuel-dependent countries (Doell *et al.*, 2021). In collectivist societies like China, social harmony and group identity are prioritised, as individuals' motivations are driven not only by personal beliefs but also by a sense of responsibility toward the

community. When individuals perceive themselves as part of a community that supports environmental norms, their pro-environmental behaviours tend to be strengthened (Steg and Vlek, 2009). Xing *et al.* (2022) investigated Chinese residents' participation in public-sphere pro-environmental behaviour, highlighting the importance of trust and identity in shaping individuals' engagement in environmental actions. Therefore, in China, group-based interventions that clearly define social norms for climate action may be more effective than individual-focused interventions.

2.3 Research in China

The impact of GCC on China is intensifying. Nevertheless, research focusing on key aspects of CCE, including public awareness, attitudes and actions towards climate change, has disproportionately focused on western countries. By contrast, studies pertaining to China are considered rare and often embedded within the broader scope of environmental education. A survey conducted by He *et al.* (2011) on Chinese students aged 16–20 found that despite their limited overall understanding of environmental issues, they have a positive attitude towards environmental issues and are willing to act. Students' environmental awareness is greatly influenced by the level of development in their region. Surveys targeting Chinese teachers have uncovered widespread misconceptions, further complicating efforts to update and improve CCE (Wan *et al.*, 2023).

In contrast to demographic factors, personal experiences, individual values or climate literacy significantly predict climate-related concerns and policy support, underscoring the importance of educational initiatives that enhance climate science understanding to foster greater public support for climate policies (Pan *et al.*, 2023). Wang *et al.* (2020a, 2020b) discovered that Chinese college students, well-informed about the national eco-strategy through political narratives, are more inclined to engage in pro-environmental behaviours, suggesting that such narratives can effectively motivate individual actions. Yang *et al.* (2021) noted that the relatively homogeneous views on GCC among Chinese citizens, shaped by unified political leadership, contrast with the more diverse and contentious perspectives prevalent in the west. While climate change in China is typically framed as a non-controversial issue that aligns with national development goals, Onokala *et al.* (2018) observed that Chinese students influenced by collectivist norms tend to exhibit fewer pro-environmental actions than their individualistic American counterparts.

3. Methods

This study uses quantitative analysis to establish a factual basis for a detailed survey that illuminates key issues within CCE, including knowledge transfer, psychological motivations, socio-political contexts and participation. The quantitative methods focus on collecting objective data, which are analysed using statistical models. Meanwhile, the qualitative methods are embedded within the theoretical framework and survey through open-ended questions and attitude assessments, which help to capture the depth of participants' understanding, motivations and behaviours. These qualitative insights allow for a more nuanced interpretation of the findings.

3.1 Bibliometric analysis via VOSviewer

The bibliometric analysis, using VOSviewer, involves co-authorship, co-citations and co-occurrence methods to comprehensively overview research trends, key authors, major topics and gaps in the CCE literature. We searched the Web of Science (WoS) Core Collection, chosen for its comprehensive coverage and rigorous inclusion criteria, and the China National Knowledge Infrastructure (CNKI), China's largest academic database. For WoS,

we focused exclusively on peer-reviewed articles by excluding "early access" publications, while CNKI searches were confined to Chinese-language documents to prevent overlap. This dual-database strategy ensured thorough coverage of both international and local research landscapes.

Step 1: Recognising the potential of CCE as an independent concept and focus area (Læssøe *et al.*, 2009), we searched WoS core collection on 9 July 2023, using the search formula TS = ("climate change education" OR "climate education"), which returned 359 results, with the types of literature including articles (n = 310), early accesses (n = 25), review articles (n = 19), meetings (n = 18), editorials (n = 10), letters (n = 1) and news items (n = 1). These publications, spanning from 1995 to 2023, came from various sources, written in various languages. After excluding the early access papers, 334 publications remained.

Step 2: A parallel search in CNKI using a Chinese-language search formula yielded 113 results, primarily from secondary education (n = 32), meteorology (n = 23), educational theory and management (n = 17), environmental science and resource utilisation (n = 17), higher education (n = 13), foreign languages (n = 10) and macroeconomics and sustainable development (n = 5). The publication dates ranged from 1962 to June 2023.

3.2 Questionnaire analysis via SPSS

3.2.1 Questionnaire methodology. Building on the themes and gaps identified in the literature review and bibliometric analysis, we designed a KAP model-based questionnaire to assess the perceptions and knowledge among university students and faculty in China. Following the methodology of Edo and Osuji (2016), we adopted a unified survey approach to present a holistic view of CCE perceptions within the higher education sector. The sampling frame for the survey was based on university students and faculty members across various academic disciplines in China, ensuring that the sample represented a wide range of perspectives. The questionnaire, developed via the widely used Sojump online platform and distributed through WeChat, allowed for broad participation, ensuring efficient distribution and collection within a given timeframe. We made efforts to ensure geographical diversity by encouraging participation from universities in both urban and rural regions, which helped capture regional disparities in CCE perceptions. A total of 525 valid responses were collected. The demographic breakdown of the respondents is detailed in Table 1, which summarises gender, age, educational level, field of study and geographical location.

The questionnaire consisted of 27 questions, organised into five sections. Section 1 gathered demographic information, including participants' gender, age, level of education, field of study and current residence. Section 2 assessed factual knowledge about global warming through a mix of single-choice and open-ended questions, which enriches the understanding of the survey data. Participants were asked to self-assess their knowledge and explain the concept of greenhouse gases (GHGs). These responses were analysed to identify discrepancies between perceived and actual knowledge, providing insights into how participants conceptualised climate change. Knowledge was objectively measured by respondents rating six statements about global warming, with correct answers being scored. Given China's political context, knowledge of climate-related policy was included. Section 3 explored participants' attitudes towards climate change, focusing on concerns, beliefs, emotions and efficacy. Collective efficacy was assessed with the question, "Do you agree that humanity will eventually solve the climate crisis?" (0 = disagree, 1 = unsure, and 2 = agree). Self-efficacy was gauged with the question, "Do you agree that everyone changing their own behaviour will help solve the climate crisis?" (0 = disagree, One individual is too small to make a change, 1 = I do not want to. It would affect my quality of life and efficiency; 2 = I want to make an effort, but I do not know how; and 3 = Yes, combating climate change

Table 1. Sample characteristics

Characteristics	Frequency (%)
Gender	
Male	209 (39.8)
Female	316 (60.2)
Age	
≤ 18	21 (4.00)
19–25	454 (86.5)
26–35	46 (8.80)
≥ 36	4 (0.80)
Education	
Bachelor's	339 (64.6)
Master's	140 (26.7)
Doctorate	46 (8.80)
Field of study	
Humanities and social sciences	294 (56.00)
Natural sciences	231 (44.00)
Location	
Eastern China	401 (76.40)
Central China	74 (14.10)
Western China	50 (9.50)

Source: Authors' own work

starts with the details, and everyone should do their part). Responses to these questions provided valuable qualitative insights into participants' motivations and emotional engagement with the climate issue. By analysing these qualitative data, we could better understand the role of collective efficacy in shaping climate-related attitudes and behaviours in the context of collectivist culture. Section 4 examined participants' involvement in climate-related activities, providing insight into their practical engagement with CCE. The final section focused on the implementation and future directions of CCE in China, exploring participants' access to CCE and their views on its current and potential forms.

3.2.2 Statistical analysis for each research question. The data were processed using SPSS and subjected to various statistical analyses to address the research questions. Given the variety of variables – from binary to non-binary – a combination of descriptive statistics, logistic regression and other relevant methods was used. Initial Shapiro–Wilk tests for *RQ3* indicated non-normal distributions across variables ($p < 0.001$), necessitating a generalised linear model (GLM) for analysing the impacts of factors such as knowledge scores, knowledge of policy and demographics on climate change concern. Respondents were asked to identify correct and incorrect statements about GCC, providing a more objective assessment of their knowledge. Correct statements included: "There is consensus on global climate change", "Greenhouse gases consist of more than carbon dioxide" and "Extreme cold weather is closely related to global warming". Incorrect statements included: "Increased solar activity and the sunspots cause global warming", "Ozone depletion causes global warming" and "Using unleaded gasoline helps reduce global warming". Knowledge scores were calculated, and policy knowledge was categorised into four levels: 0 for "unaware", 1 for "aware but not knowledgeable", 2 for "knowledgeable" and 3 for "know very well".

For *RQ4*, a multiple-choice survey assessed respondents' attitudes towards climate change, with data analysed using descriptive statistical methods to determine the frequency and proportion of each selected attitude. Logistic regression was used to analyse the relationships between knowledge scores, higher knowledge of climate policy and attitudes toward climate change. Additionally, a binary logistic regression was used to analyse how self-efficacy, collective efficacy and climate experience influence attitudes, supplemented by Pearson correlation analyses to examine the relationships between these variables.

For *RQ5*, the study categorised participation in climate-related activities into four levels: 0 = not participated and not concerned (n = 99, 18.9%), 1 = willing to participate but unaware of how (n = 282, 53.7%), 2 = participates occasionally (n = 125, 23.8%) and 3 = participates frequently (n = 19, 3.6%). A multinomial logistic regression examined the link between knowledge scores and participation levels. A nominal logistic regression identified shifts in attitudes and participation relative to the baseline of "not participated and not concerned". Additional multinomial logistic regressions analysed the relationships between attitudes, personal and collective efficacy, climate change concern and participation.

For *RQ6*, a chi-square test was used to detect regional differences in the implementation of CCE. The results revealed significant variations in how CCE is applied across different regions in China, reflecting disparities in resources, educational priorities and policy enforcement. Understanding these differences is crucial for tailoring CCE strategies that are effective and context-sensitive, ensuring that all regions benefit from enhanced climate education initiatives.

4. Results

4.1 What are the trends, main contributors and focal points in climate change education research?

As illustrated by Figure 1, global CCE research shows significant growth and evolving dynamics within the field, which has developed substantially since its inception in the mid-1990s. The field began to gain significant momentum after 2011, marked by an exponential increase in scholarly publications, peaking in 2022. The number of publications and citations in 2019 nearly doubled those of the previous year, indicating a growing academic interest in CCE. The increase in citations continued until it peaked in 2022. In China, CCE research mirrors these global trends, as shown in Figure 2. Despite a delayed start in 2005, Chinese research saw notable peaks in 2011, 2015 and 2020, with continued growth. By the first half of 2023, 11 new publications were recorded. However, predictive models such as ARIMA

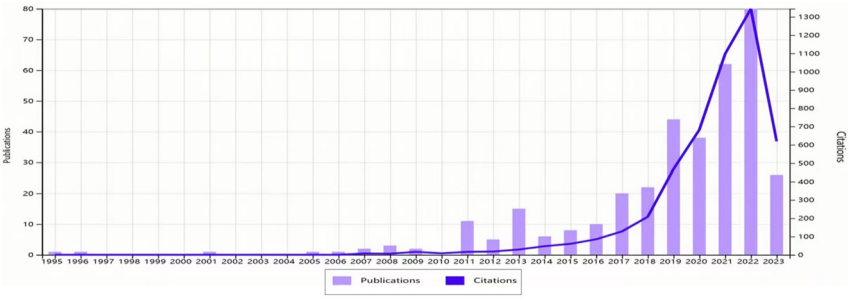

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Figure 1. Year-based trend of included publications and citations in WoS

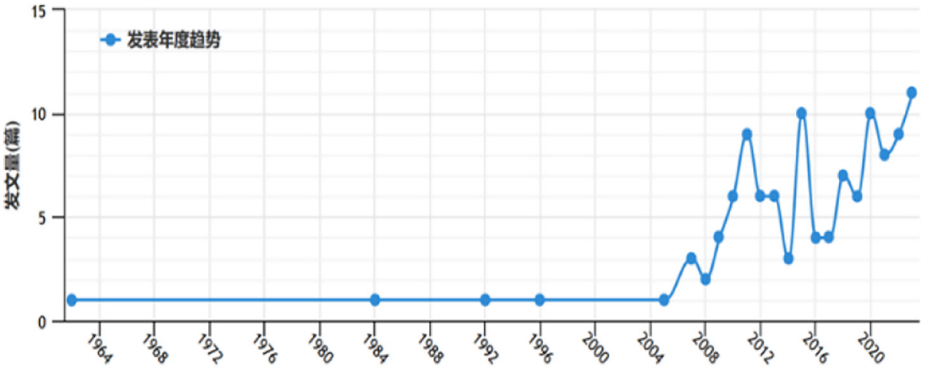

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Figure 2. Year-based trend of included publications and citations in CNKI

(0,0,0), GM (1,1), and LSTM failed to effectively forecast future trends due to data discontinuity and volatility.

The complexity and constantly evolving nature of CCE necessitate sophisticated analytical approaches to recognise patterns and influences within the field. The bibliometric analysis provided both quantitative aspects of collaboration and influence and qualitative insights into the thematic development of CCE research globally and in China. By focusing on co-authorships with authors, organisations and countries, we obtained a macro-level overview of the structural dynamics and the thematic streams in CCE research, which forms a basis for further CCE implementation and influence.

As shown in Figure 3, 37 authors with a minimum of two publications and 50 citations were identified. The top ten contributors are Martha C. Monroe, Richard R. Plate, Maria Ojala, Kathryn T. Stevenson, M. Nils Peterson, Jeremy N. Bailenson, Anthony Leiserowitz, David Rousell, Edward W. Maibach and Eugene C. Cordero. Despite individual contributions, the overall network of collaborations among scholars appeared sparse, suggesting a potential area for fostering more integrated and interdisciplinary connections. Figure 4 provides a visual representation of institutional connections within this field. In total, 62 institutions have published at least two articles on CCE, with the University of Florida, the University of Innsbruck, Virginia Tech, the University of Washington and Stockholm University being among the top five. HAW Hamburg stands out with a total link strength of 13 in the citation network, indicating a central role in disseminating influential CCE research. Some institutions, including UC Berkeley and Swansea University, appeared more isolated.

Geographically, the USA leads in publication output, followed by Australia, England, Germany, Canada, Finland, Sweden, China, Austria and Spain, as shown in Figure 5, which details the distribution of publication output by country. Extensive international collaborations, particularly between Chinese researchers and their colleagues worldwide, reflect the overall development of funding, policy engagement and academic output in CCE. Figure 6 illustrates the ten most-cited journals are *Environmental Education Research*, *International Journal of Science Education*, *Climatic Change*, *Journal of Environmental Education*, *Global Environmental Change-Human and Policy Dimensions*, *Nature Climate Change*, *Sustainability*, *Journal of Environmental Psychology*, *Journal of Cleaner Production* and *Journal of Research in Science Teaching*, holding significant influence and authority in this domain.

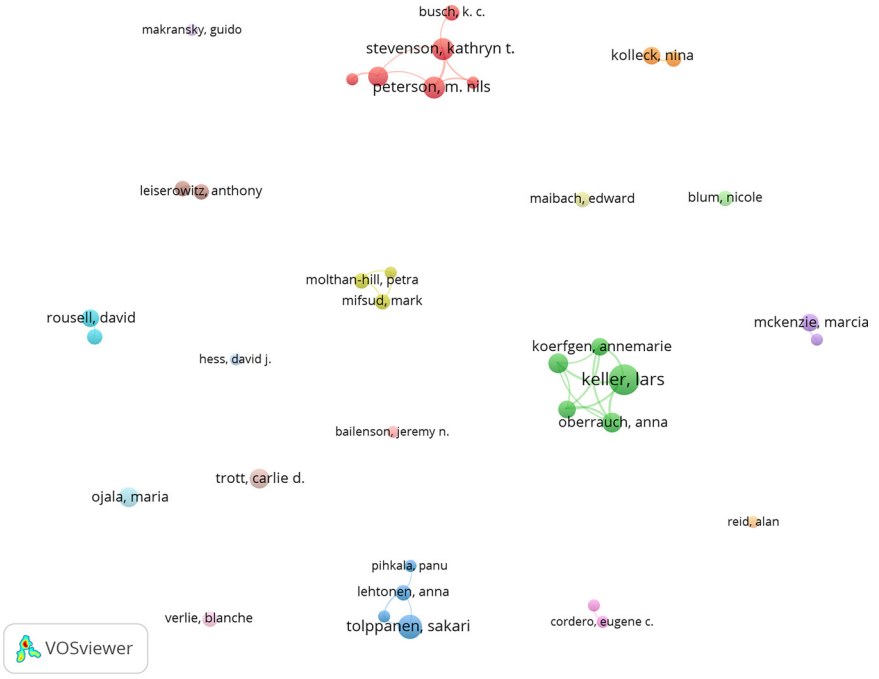

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Figure 3. Citation networks of authors

Figure 7 illustrates the keyword co-occurrence map, where different colours represent distinct clusters. The red and purple clusters both emphasise the role of psychological constructs and personal values in climate change behaviour. The red cluster suggests that understanding these motivational aspects can enhance educational interventions and influence participation in CCE activities. Similarly, the purple cluster focuses on "perception" and "risk", examining how stakeholders' views on climate change risks impact their roles in mitigation efforts. These elements are crucial for developing effective CCE strategies and addressing stakeholder concerns.

The green cluster discusses the challenges of CCE implementation across different socio-political contexts, raising concerns about its effectiveness in various regional settings. This observation underscores ongoing efforts to integrate sustainability into educational curricula. The terms "children" and "youth" imply the importance of age-appropriate and effective pedagogy. Complementing this, the yellow cluster emphasises the role of teachers in communicating climate change knowledge and identifying gaps in understanding the depth and effectiveness of knowledge acquisition and dissemination. This aligns with the purple cluster's emphasis on "literacy", indicating a broader concern for improving the foundational aspects of CCE.

In the blue cluster, the connection between "emotions", "hope", "policy", "engagement" and "higher education" unveils a comprehensive framework for understanding CCE within higher educational settings. This suggests that strategic pedagogies and positive emotions, fuelled by policies, are essential for motivating students and teachers to engage in mitigation

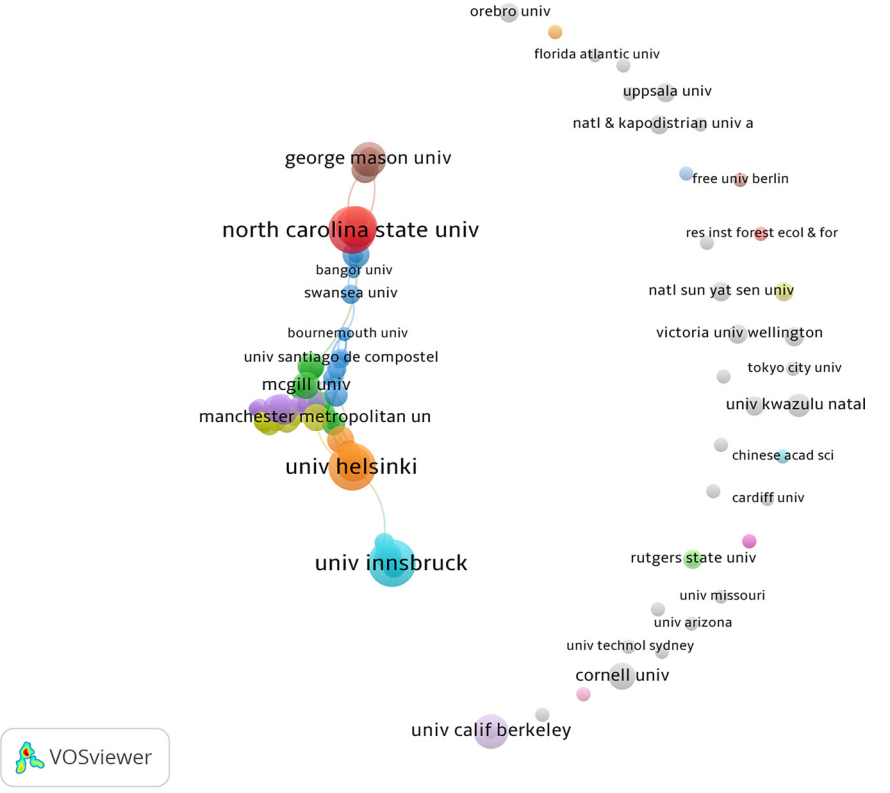

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Figure 4. Citation networks of organisations

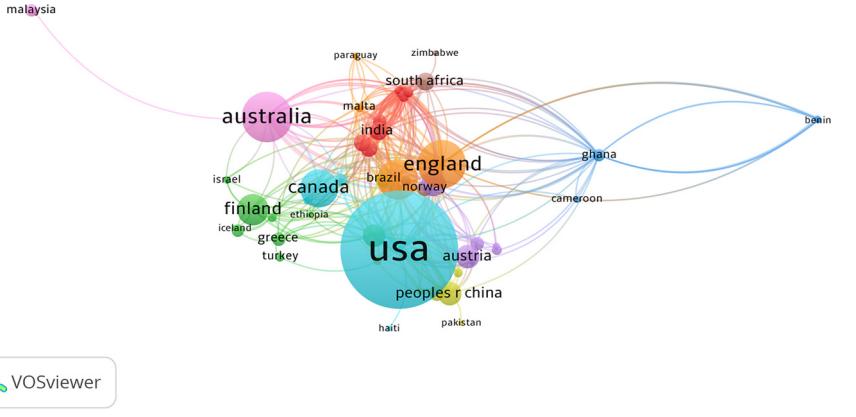

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Figure 5. Citation networks of countries

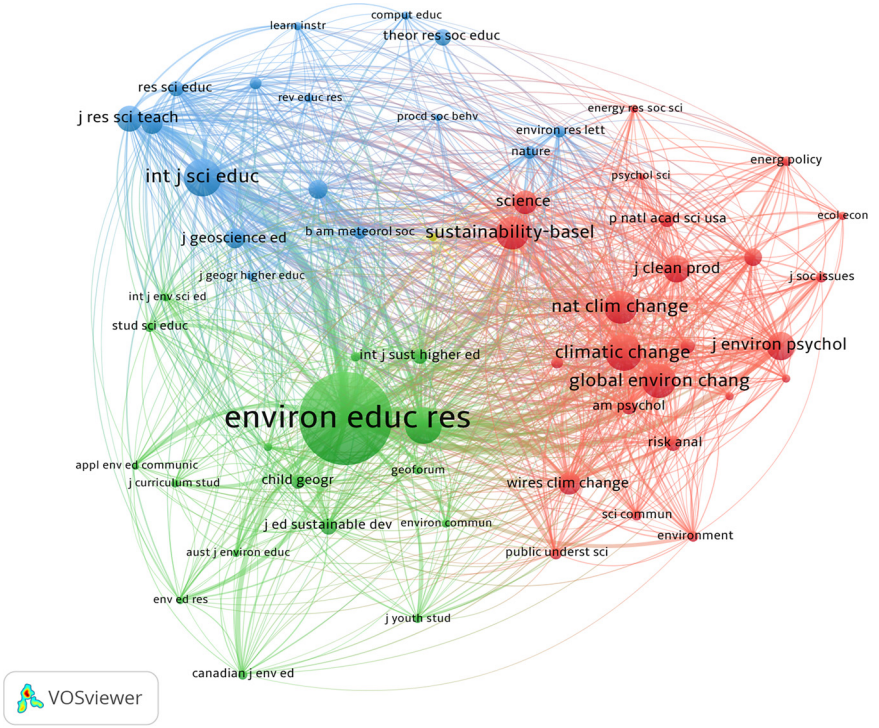

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Figure 6. Citation networks of sources

actions. However, the substantial distance between "higher education" and the central term "climate change education", compared to the proximity of "children" in the green cluster to "climate change education", indicates that CCE in higher education may not be as thoroughly integrated as in primary and secondary education. This observation indicates a potential area of research into effective emotional and policy-driven engagement, particularly in higher educational institutions.

4.2 RQ2: what knowledge do young Chinese people hold regarding climate?

Figure 8 presents the correlation between Chinese university students' and teachers' self-assessment and factual knowledge of GCC. Participants were asked to rate their understanding of GCC on a five-point scale ranging from "Not know" to "Know very well", followed by a request to define GHG. It was observed that 49.5% acknowledged that they did not know much or at all, and 34.3% (n = 180) had difficulties with self-assessment. Of those who identified as "Knowledgeable" and "Know Very Well", 63% (n = 260) failed to explain the GHG emissions, highlighting a potential overestimation. The valid explanations can be divided into seven categories, with the most prominent misconception being that GHGs are equivalent to CO2. Confusion between the shortwave radiation emitted by the sun and absorbed by the Earth and the longwave radiation re-emitted after being absorbed by the Earth is also prevalent.

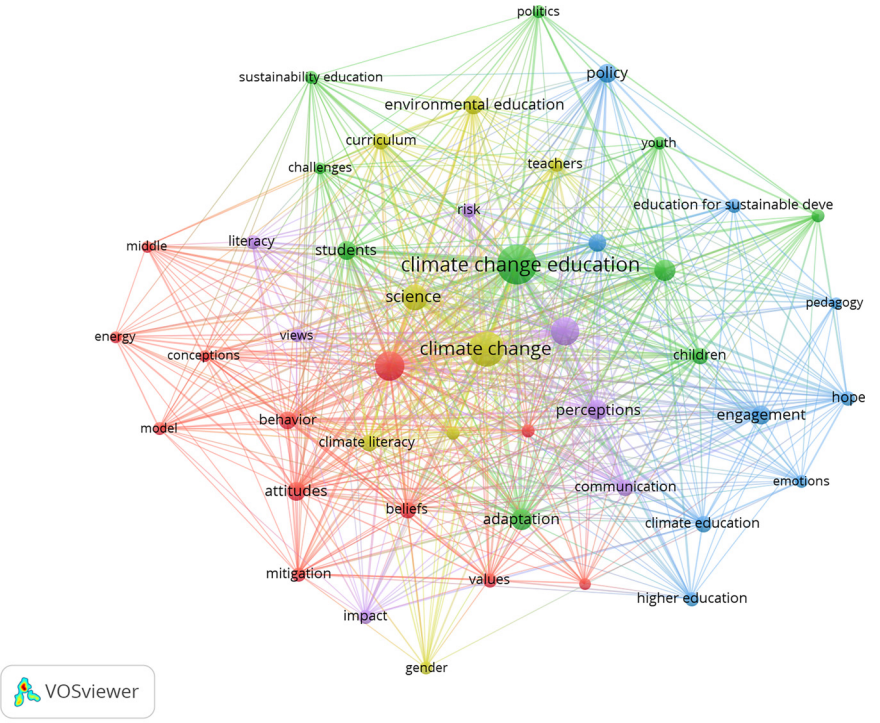

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Figure 7. Knowledge map of CCE

Knowledge scores ranged from a minimum of 2 to a maximum of 6, with an average knowledge score of 3.9048, as shown in Figure 9. The most common score was 3, accounting for 33.1% of the total (n = 174), followed by higher scores of 4 (29.5%) and 5 (23.6%). This indicates a moderate understanding of the related issues. The proportion of students scoring at the extremes, 2 and 6, were identical, each accounting for 6.9% of the respondents, reflecting the variance in knowledge levels across the surveyed population. Respondents self-identifying as "Knowledgeable" and "Know Very Well" were mostly concentrated around mid-range scores of 3 and 4, which is further supported by Figure 10. The result supports the earlier findings where they fail to correctly explain GHG.

Understanding government policies is a crucial part of the knowledge component of the KAP model, especially in China's unique political system, where government policies significantly influence public perception and action. China's goals for carbon peaking and carbon neutrality represent a significant national response to global climate governance. Figure 11 shows the respondents' level of knowledge regarding the two goals. The results showed that only 2.1% of respondents were unaware of the policy, 28.4% had heard of it but possessed no detailed knowledge, 52.2% recognised its general importance and 17.3% were well-acquainted with its content. This indicates a high level of awareness among the surveyed university students and teachers in China.

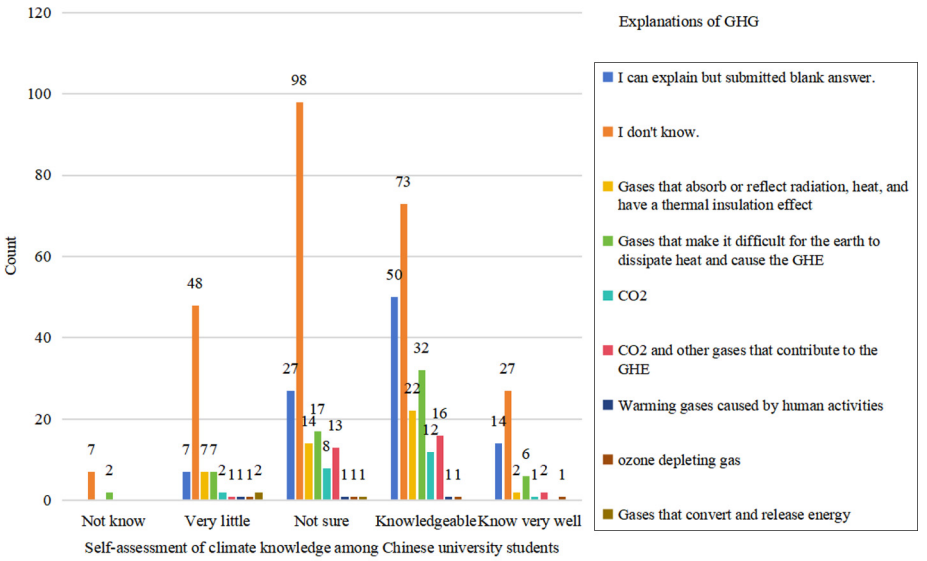

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Figure 8. Self-assessment and actual understanding of climate knowledge

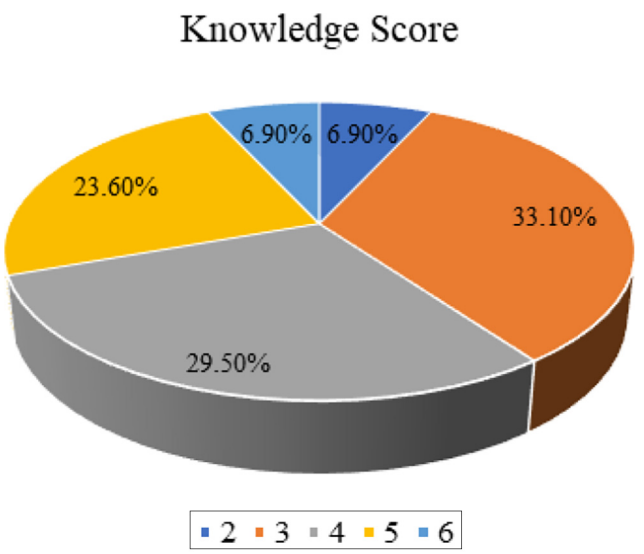

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Figure 9. Scientific knowledge score of Chinese university students and teachers

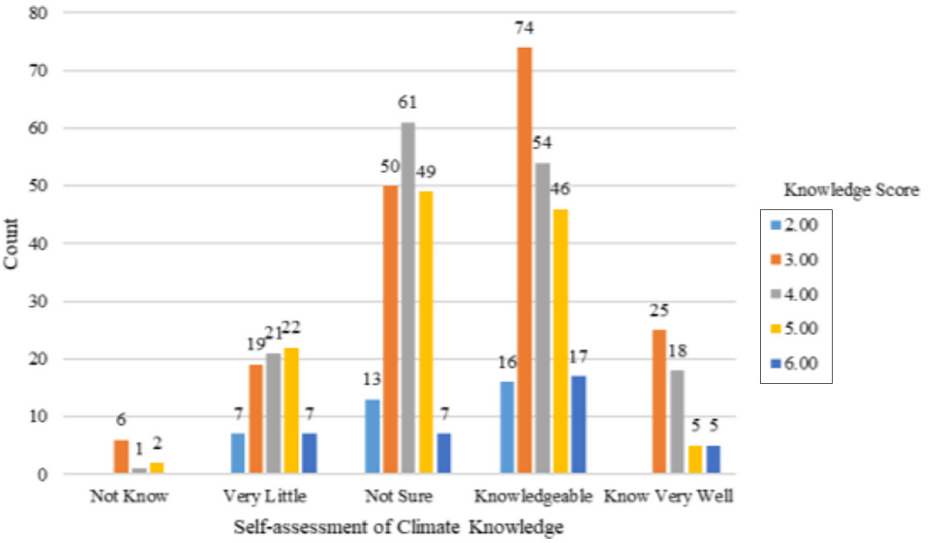

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Figure 10. Comparison between self-assessment and actual scientific knowledge

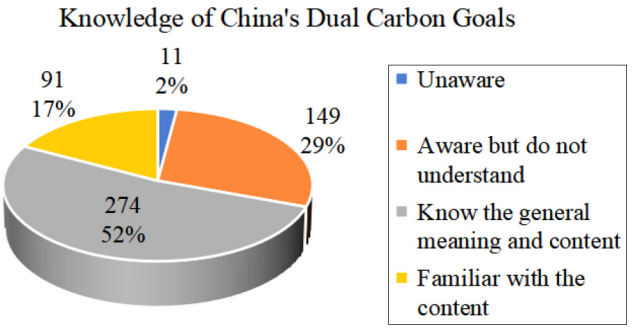

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Figure 11. Policy knowledge of Chinese university students and teachers

4.3 RQ3: how do demographic factors and knowledge of climate change influence the level of concern among university students and teachers?

This study tested the hypotheses derived from the KAP model on the influence of academic majors on GCC concerns. We hypothesised that climate change concerns would vary significantly by climate change knowledge and the subject of study, while other demographic factors would exert minimal influence. Regression analysis within the GLM revealed that both general climate change knowledge, represented by the knowledge score, and knowledge of China's climate policy significantly affected concern levels. Specifically, an increase in general climate knowledge was associated with a decrease in concern ($B = –0.063$, $p = 0.019$),

whereas familiarity with national policies increased concern levels (B = 0.231, p = 0.001). Among demographic variables, only the field of study showed a significant influence (B = –0.167, p = 0.011), as shown in Table 2, where natural sciences learners (coded as 2) exhibited less concern than those who study humanities and social sciences (coded as 1). Additionally, Table 2 shows no significant effects of gender, age, education level, and location on climate change concerns.

According to Table 4, the Omnibus test for model fit showed a likelihood ratio chi-square of 21.800 with 16 degrees of freedom (p = 0.150), suggesting the model did not significantly differentiate the average responses across groups. However, a significant interaction was found between age (19–25 years) and field of study (natural sciences), indicating lower concern among natural sciences (B = –1.67, p = 0.011), as shown in Table 3. Despite the overall lack of significant differentiation, these results highlight the role of academic specialisation and climate knowledge in shaping GCC concerns, which reinforces the hypothesis that knowledge and field of study play crucial roles.

4.4 RQ4: what attitudes towards climate change are prevalent among Chinese university students and teachers, and how do they correlate with their knowledge of climate change?

Figure 12 shows the attitudes of respondents toward GCC issues. Concern about GCC was expressed by 56.8% of participants, making it the most commonly reported emotion. Fear and anxiety were less prevalent, reported by only 19.2% and 24.2% of respondents, respectively. A minority of 7.4% felt indifferent, stating that climate change had no impact on them. Despite mixed emotions, a slim majority of 51% maintained hopefulness about resolving climate change issues. Feelings of helplessness were reported by only 17.5% of the respondents.

Table 2. Demographic and climate change concern characteristics of university students and teachers in China

Characteristics	S-W statistic	df	S-W sig
Gender			
Male	0.831	209	0.000
Female	0.780	316	0.000
Age			
≤ 18	0.803	21	0.001
19–25	0.800	454	0.000
26–35	0.814	46	0.000
≥ 36	0.729	4	0.024
Education			
Bachelor's	0.804	339	0.000
Master's	0.800	140	0.000
Doctorate	0.825	46	0.000
Field of study			
Humanities and social sciences	0.789	294	0.000
Natural sciences	0.819	231	0.000
Location			
Eastern China	0.801	401	0.000
Central China	0.811	74	0.000
Western China	0.794	50	0.000

Source: Authors' own work

Table 3. Factors influencing GCC concerns

Predictor	B	SE	Beta	*p*
Constant	1.555	0.284		0.000
Knowledge score	−0.063	0.027	−0.101	0.019
Knowledge of governmental climate policy	0.231	0.039	0.252	0.000
Field of study	−0.167	0.065	−0.125	0.011
Gender	−0.013	0.066	−0.01	0.842
Age	0.083	0.084	0.049	0.328
Education	0.025	0.053	0.024	0.638
Location	0.086	0.045	0.084	0.056

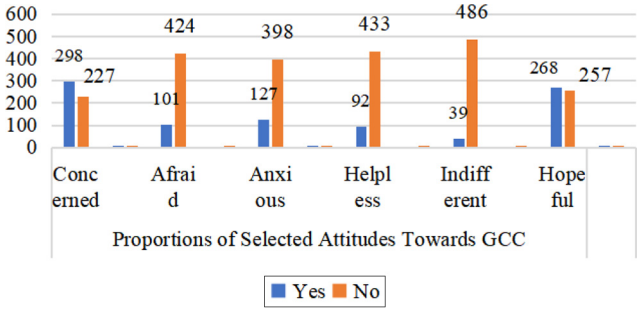
Source: Authors' own work

Table 4. Chi-square analysis of factors influencing GCC concerns

Source	Type III Wald chi-square	df	Sig
Gender	0.131	1	0.717
Age	2.466	3	0.482
Education	1.023	2	0.599
Field of study	6.097	1	0.014
Location	0.535	2	0.765
Gender * Field of study	0.315	1	0.575
Age * Field of study	4.943	2	0.084
Education * Field of study	0.355	2	0.838
Field of study * Location	2.142	2	0.343

Dependent variable: Level of concern about global climate change

Source: Authors' own work



Source: Authors' own work

Figure 12. Proportions of selected attitudes towards GCC

The logistic regression analysis, as shown in Table 5, revealed that a higher scientific knowledge score significantly reduces the likelihood of experiencing fear of climate change (B = –0.398, p = 0.001). However, knowledge did not significantly affect other attitudes, such as worry, anxiety, helplessness, indifference and hopefulness. Interestingly, increased

Table 5. Logistic regression analysis of knowledge score on various attitudes towards GCC

Variable	Worried	Afraid	Anxious	Helpless	Indifferent	Hopeful
Knowledge score	B = –0.076, SE = 0.092, p = 0.410, Exp(B) = 0.927	B = –0.398, SE = 0.117, p = 0.001, Exp(B) = 0.692	B = –0.196, SE = 0.102, p = 0.055, Exp(B) = 0.822	B = –0.116, SE = 0.115, p = 0.311, Exp(B) = 0.890	B = 0.110, SE = 0.198, p = 0.577, Exp(B) = 1.117	B = 0.014, SE = 0.087, p = 0.871, Exp(B) = 1.014
Policy knowledge	B = 0.232 SE = 0.123 p = 0.060 Exp(B) = 1.261	B = 0.128 SE = 0.155 p = 0.407 Exp(B) = 0.137	B = 0.047 SE = 0.142 p = 0.739 Exp(B) = 1.048	B = –0.279 SE = 0.160 p = 0.081 Exp(B) = 0.756	B = –0.430 SE = 0.232 p = 0.064 Exp(B) = 0.651	B = 0.250 SE = 0.123 p = 0.042 Exp(B) = 1.283
Collective efficacy	B = 0.014, SE = 0.156, p = 0.926, Exp(B) = 1.015	B = 0.054, SE = 0.187, p = 0.773, Exp(B) = 1.056	B = –0.259, SE = 0.169, p = 0.125, Exp(B) = 0.772	B = –0.769, SE = 0.189, p = 0.000, Exp(B) = 0.464	B = –0.996, SE = 0.332, p = 0.003, Exp(B) = 0.369	B = 0.725, SE = 0.151, p = 0.000, Exp(B) = 2.064
Self-efficacy	B = 0.529, SE = 0.153, p = 0.000, Exp(B) = 1.698	B = 0.300, SE = 0.181, p = 0.098, Exp(B) = 1.350	B = 0.257, SE = 0.145, p = 0.077, Exp(B) = 1.293	B = –0.024, SE = 0.127, p = 0.849, Exp(B) = 0.976	B = –0.572, SE = 0.159, p = 0.000, Exp(B) = 0.564	B = 0.234, SE = 0.111, p = 0.035, Exp(B) = 1.264
GCC experience	B = 0.790, SE = 0.125, p = 0.000, Exp(B) = 2.203	B = 0.603, SE = 0.157, p = 0.000, Exp(B) = 1.828	B = 0.458, SE = 0.137, p = 0.001, Exp(B) = 1.582	B = 0.058, SE = 0.140, p = 0.680, Exp(B) = 1.059	B = –1.578, SE = 0.243, p = 0.000, Exp(B) = 1.206	B = –0.149, SE = 0.109, p = 0.172, Exp(B) = 0.862

Source: Authors' own work

policy knowledge significantly enhances hopefulness (p = 0.042, Exp(B) = 1.283), supporting the hypothesis that awareness of policies fosters more positive attitudes.

Binary logistic regression analysis presented in Table 5 showed that collective efficacy positively predicts hopefulness (B = –0.725, p = 0.000) and negatively predicts helplessness (B = –0.769, p = 0.000) and indifference (B = –0.996, p = 0.003). Self-efficacy is associated with greater worry (B = 0.529, p = 0.000) and hopefulness (B = 0.234, p = 0.035) while reducing indifference (B = –0.572, p = 0.000). Personal climate change experiences significantly increase worry (B = 0.790, p = 0.000), fear (B = 0.603, p = 0.000) and anxiety (B = 0.458, p = 0.001) and significantly reducing indifference (B = –1.578, p = 0.000).

As shown in Table 6, a Pearson correlation analysis confirmed significant positive correlations between scientific knowledge and collective efficacy (R = 0.109, p = 0.012), as well as between policy knowledge and both collective (R = 0.184, p = 0.000) and self-efficacy (R = 0.159, p = 0.000). A strong correlation was also observed between collective and self-efficacy (R = 0.253, p = 0.000). These results elucidate the complex interplay between knowledge, efficacies and attitudes towards GCC, highlighting the importance of enhanced knowledge and effectiveness in fostering more engaged and hopeful attitudes towards climate change.

4.5 RQ5: what factors, including attitudes, influence Chinese university students' and teachers' participation in climate-related activities?

This study assessed the influence of knowledge and attitudes on participation in climate change mitigation activities. Table 7 presents the logistic regression analysis examining the influence of scientific and policy knowledge on participation in climate change mitigation activities. Our results revealed that higher scientific knowledge did not correlate with increased activity participation, as the odds ratios for transitioning from non-engagement to more active roles were consistently below 1.0 ($0.200 \leq p \leq 0.365$). This implies that scientific knowledge alone is insufficient to motivate action.

Table 6. Pearson correlation between knowledge score, collective efficacy and self-efficacy

Variable	Scientific knowledge score	Policy knowledge	Collective efficacy	Self-efficacy
Knowledge score				
Pearson correlation	1	0.056	0.109	−0.068
Sig (2-tailed)		0.198	*0.012*	0.118
Policy knowledge				
Pearson correlation	0.056	1	0.184	0.159
Sig (2-tailed)	0.198		*0.000*	*0.000*
Collective efficacy				
Pearson correlation	0.109	0.184	1	0.253
Sig (2-tailed)	0.012	*0.000*		*0.000*
Self-efficacy				
Pearson correlation	−0.068	0.159	0.253	1
Sig (2-tailed)	0.118	*0.000*	*0.000*	0
N	525		525	525

Source: Authors' own work

Table 7. The influence of knowledge on participation

Variable category	Participation category	B	SE	Wald	*p*	Exp(B)
(scientific)	Willing but unaware of how to	−0.142	0.111	1.644	0.200	0.868
Knowledge score	Occasionally participates	−0.121	0.128	0.892	0.345	0.886
	Frequently participates	−0.218	0.241	0.821	0.365	0.804
Policy knowledge	Willing but unaware of how to	0.513	0.172	8.897	0.003	1.671
	Occasionally participates	1.172	0.209	31.481	*0.000*	3.228
	Frequently participates	2.068	0.474	30.215	*0.000*	13.566

Source: Authors' own work

However, policy knowledge significantly influenced participation levels. Each unit increase in policy knowledge raises the likelihood of moving from non-participation to "willing to participate but unaware of how" by 67.1% (p = 0.003). Additionally, policy knowledge significantly boosted the odds of occasional participation (Exp(B) > 3, p = 0.000) and frequent participation (Exp(B) > 13, p = 0.000), underscoring the pivotal role of policy awareness in enhancing engagement.

We also assessed the impact of various attitudes that are operationalised as binary variables – worried, afraid, anxious, indifferent, hopeless and hopeful – towards climate change on participation levels in climate-related activities. As shown in Table 8, expressing worry (p = 0.003, Exp(B)=2.405) and hope (p = 0.022, Exp(B)=1.989) about climate change significantly increases the likelihood of being willing to participate but not knowing how to start. However, indifference significantly reduced the willingness to engage (p = 0.003, Exp (B) = 0.236) and discouraged occasional participation (p = 0.009, Exp(B) = 0.196). An outlier was observed regarding the impact of feeling hopeless on the "frequently participates" category (n = 19, 3.6%) due to the small sample size.

Table 8. The influence of attitudes on participation

Participation category	Attitudes	B	SE	Wald	*p*	Exp(B)
Willing but unaware of how to	Worried	0.877	0.293	8.953	*0.003*	2.405
	Afraid	0.450	0.397	1.283	0.257	1.568
	Anxious	0.158	0.341	0.214	0.644	1.171
	Hopeful	0.688	0.299	5.274	*0.022*	1.989
	Hopeless	0.088	0.352	0.062	0.803	1.092
	Indifferent	−1.445	0.479	9.112	*0.003*	0.236
Occasionally participates	Worried	0.492	0.327	2.274	0.132	1.636
	Afraid	0.262	0.440	0.354	0.552	1.299
	Anxious	0.504	0.369	1.870	0.172	1.655
	Hopeful	0.560	0.335	2.805	0.094	1.751
	Hopeless	0.384	0.384	0.999	0.317	1.468
	Indifferent	−1.631	0.621	6.906	*0.009*	0.196
Frequently participates	Worried	0.476	0.647	0.541	0.462	1.609
	Afraid	0.267	0.755	0.125	0.724	1.306
	Anxious	−0.811	0.833	0.947	0.330	0.444
	Hopeful	−0.331	0.629	0.277	0.599	0.718
	Hopeless	−20.321	0.000	.	.	1.495E-09
	Indifferent	−1.93	1.214	2.526	0.112	0.145

Source: Authors' own work

Table 9 presents the influence of personal and collective efficacy, along with concern levels, on participation in climate change activities. Both personal and collective efficacy significantly predict engagement in climate change activities. Individuals confident in their ability to mitigate global warming were nearly twice as likely to express willingness to participate ($p = 0.000$, Exp(B) = 1.915), and collective efficacy also positively influenced this willingness, although less pronounced ($p = 0.074$, Exp(B) = 1.414). For actual involvement, both efficacy beliefs significantly predicted occasional and frequent participation, with collective efficacy strongly impacting frequent participation ($p = 0.001$, Exp(B) = 5.691).

Concern about climate change is also a critical component of attitudes within the KAP model, serving as a strong predictor of participation. An increased level of concern significantly boosts participation across all categories. Higher concern levels increased the likelihood of expressing a willingness to act yet unsure of how to act by over four times ($p = 0.000$, Exp(B) = 4.346), enhanced occasional participation ($p = 0.000$, Exp(B) = 5.180) and significantly increased frequent participation ($p = 0.000$, Exp(B) = 15.498).

4.6 RQ6: What are the regional disparities in implementing climate change education across China?

This study investigated the regional differences in the delivery of CCE across China. The chi-square test results revealed no significant differences in CCE delivery across regions, with Pearson's chi-square values exceeding 0.05 for all categories, ranging from never receiving CCE, learning about national policies, specific courses, expert lectures, campus or club activities, extra-school activities, to other forms and showing the asymptotic significance of 0.078, 0.343, 0.459, 0.949, 0.245, 0.797, and 0.733 respectively. Nonetheless, percentage data highlight some regional trends, as shown in Figure 13, which illustrates the forms of CCE received by Chinese youth in different regions. Learning about national policies and attending specific courses are the predominant forms of CCE in the Eastern (51.6%, 50.6%), Central (60.8%, 50.7%), and Western (52%, 42%) regions of China. Over 70% of innovative CCE forms, such as expert lectures and extracurricular activities, were reported from the developed Eastern region, suggesting that economic factors may influence the accessibility and diversity of CCE offerings.

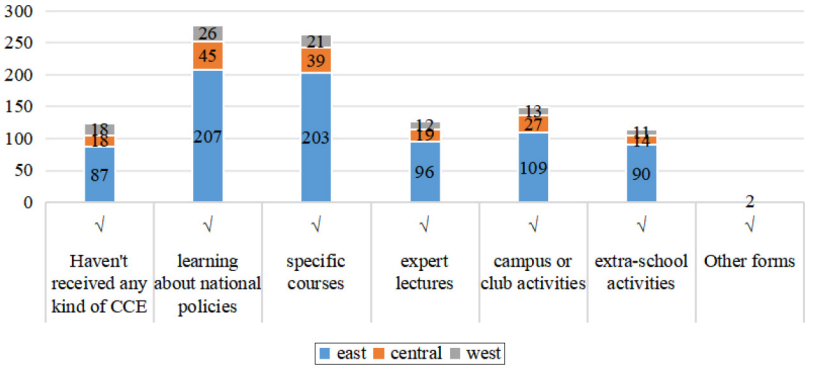
4.7 RQ7: what are the expectations and preferences of students and educators regarding the future implementation of climate change education?

When it comes to the necessity of including CCE in schools, Figure 14 shows that 88% of Chinese university students and teachers said yes, while 6.5% were hesitant, and 5.5%

Table 9. The influence of efficacies and concern on participation

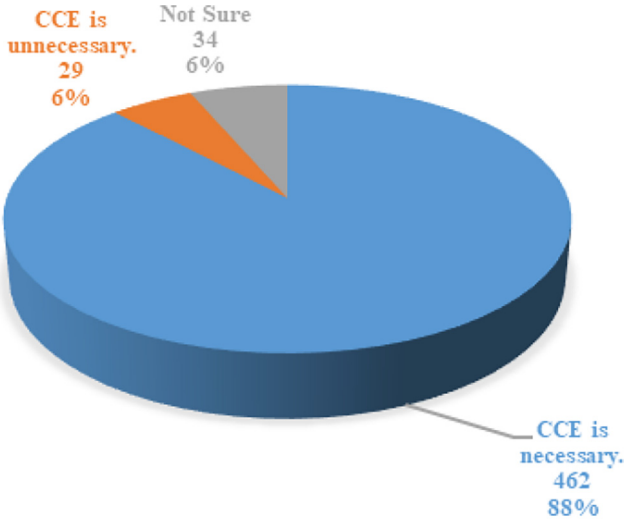
Participation category	Attitudes	B	SE	Wald	*p*	Exp(B)
Willing but unaware of how to	Collective efficacy	0.346	0.194	3.192	0.074	1.414
	Self-efficacy	0.650	0.119	29.813	0.000	1.915
	Levels of concern	1.469	0.208	49.965	0.000	4.346
Occasionally participates	Collective efficacy	0.627	0.226	7.689	0.006	1.871
	Self-efficacy	0.598	0.152	15.506	0.000	1.819
	Levels of concern	1.645	0.240	46.959	0.000	5.18
Frequently participates	Collective efficacy	1.739	0.529	10.819	0.001	5.691
	Self-efficacy	0.618	0.393	2.473	0.116	1.854
	Levels of concern	2.741	0.456	36.159	0.000	15.498

Source: Authors' own work



Source: Authors' own work

Figure 13. Forms of CCE received by Chinese youth in different regions

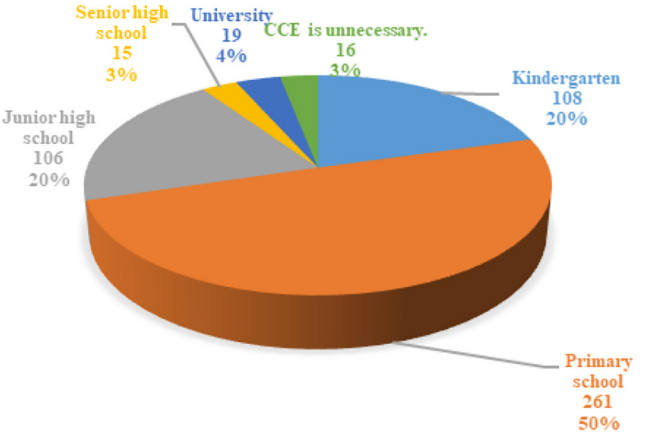


Source: Authors' own work

Figure 14. Attitudes of Chinese university students towards CCE

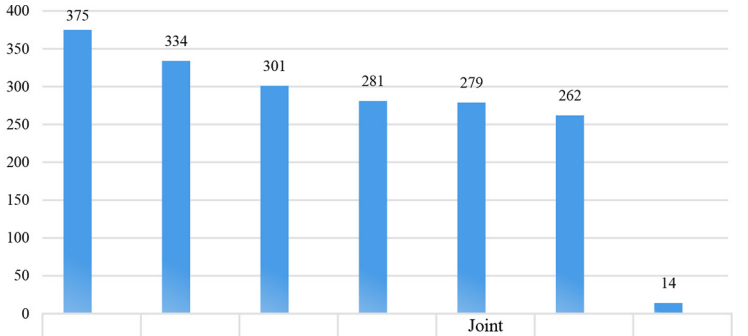
considered it unnecessary. Half of those who agreed that CCE should enter campus thought it should begin in primary school, while 20% each thought that kindergarten and junior high school were the optimal starting stages, as illustrated in Figure 15, apart from the 3% who insisted that CCE was unnecessary.

Figure 16 illustrates the ideal forms for the future CCE, as commented on by students and teachers. Compared to the traditional top-down curriculum (53.5%), school activities (71.4%) and innovative extracurricular activities (63.6%) were the most popular. Additionally, over half of the respondents supported schools working with local communities and governments



Source: Authors' own work

Figure 15. The most suitable stage Chinese university students believe to start CCE



	Campus themed activities	Activities in innovative forms	Expert lectures that enable students to interact with scientists	Specialized courses	Joint activities between schools, communities, and local governments	Film and book sharing sessions	Other
times selected	375	334	301	281	279	262	14
Proportion of times selected	71.40%	63.60%	57.30%	53.50%	53.10%	49.90%	2.70%

Source: Authors' own work

Figure 16. Expected CCE forms of Chinese university students and teachers

to provide more accessible platforms for student engagement. Suggestions for conducting advice-sharing sessions and field visits were provided.

Participants were required to rank the actors responsible for solving the climate crisis according to their importance (the first ranking – 5 points, second – 4, third – 3, fourth – 2, and fifth – 1). Table 10 summarises the rankings of different actors according to the average score. Chinese university students and teachers believe that the government plays the most

Table 10. The importance of different subjects in coping with GCC

Subjects	Top choice	Second choice	Third choice	Fourth choice	Fifth choice	Not selected	Mean	SD
Government actions	292	129	64	24	5	11	4.23	1.11
Scientific innovations	88	116	186	59	27	49	3.06	1.432
International cooperation	70	168	89	64	94	40	2.88	1.538
Individual actions	69	44	80	87	185	60	2.13	1.571
Mass media	6	31	55	228	142	63	1.75	1.064

Source: Authors' own work

important role in addressing climate change (mean = 4.23). Innovation and technology are expected to mitigate or adapt to climate change (mean = 3.06). Less expected was international cooperation (mean = 2.88). Surprisingly, the respondents had the lowest expectations on personal action (mean = 2.13) and mass media (mean = 1.75).

5. Discussion

The early onset and rapid escalation of CCE research in global contexts contrast with its later start in China. Nevertheless, China has shown a robust increase in CCE publications, particularly following major international climate commitments and policy events, such as China's pledges at the 2015 Paris Climate Conference to peak carbon emissions by 2030 and achieve carbon neutrality by 2060. As China integrates climate change into its policies and curricula, it fosters greater public understanding and engagement, which is crucial for empowering citizens to take action towards mitigation and adaptation, a core objective of climate-related sustainable development.

The identification of key contributors highlights the uneven geographical distribution of academic output and the sparse network of collaborations, suggesting a critical gap in transcultural and interdisciplinary approaches to CCE. Our survey indicates that this lack of collaboration leads to the prevalent misunderstandings among students and teachers. The moderate average knowledge scores and the widespread misconceptions highlight the need for broader integration of diverse educational methodologies, as suggested by the bibliometric findings. Furthermore, the survey highlighted the necessity for specialised training for teachers to prevent the transmission of deep-rooted misconceptions (Leal Filho *et al.*, 2010; Hestness *et al.*, 2019), which is also mirrored in the bibliometric cluster emphasising the role of educators in knowledge transfer.

Aligning with the thematic clusters focusing on psychological motivations and socio-political adaptations identified in the bibliometric analysis, this study presents several significant findings that resonate with, yet also diverge from, previous research on CCE. One of the major contributions of this study is its examination of the gap between self-assessed knowledge and actual knowledge among Chinese university students and teachers. People tend to overestimate their understanding of GCC, particularly in terms of scientific facts, which is also the case in the West (Hamilton and Fogg, 2019; Thaller and Brudermann, 2020). This discrepancy may stem from prolonged environmental education in China and the cultural emphasis on harmony between humans and nature, which could potentially foster complacency and reduce the perceived urgency of acquiring new information. Habituation due to repeated exposure to similar information can also diminish sensitivity and interest over time (Berlyne, 1960). Similar to the study by Liu *et al.* (2024), Chinese students and teachers in the humanities and social sciences have a better environmental understanding and

concern than those in natural sciences. Possible reasons include the humanities' focus on ethical, social and cultural dimensions to provide a contextual understanding of climate change more than scientific facts (Corner *et al.*, 2015).

Moreover, we incorporated climate policy knowledge into the KAP model, a key distinction in this study. Given China's strong emphasis on climate policy and its pivotal role in global climate governance, understanding climate policy knowledge is crucial (Wang *et al.*, 2020a, 2020b). This resonates with the broader vision of quality education as an enabler of informed decision-making and action on climate issues. While traditional climate change knowledge diminishes emotional distress and boosts collective efficacy, we found that policy knowledge plays an equally important role in shaping individuals' positive attitudes towards climate change and collective efficacy, which in turn increases negative feelings. The impact of scientific knowledge on actual participation in climate-related activities is limited unless supported by comprehensive strategies that elucidate clear pathways (Bamberg and Möser, 2007; Thaker *et al.*, 2019). For effective climate education, curricula must provide clear, actionable insights into the implications of climate policies to foster a more informed and proactive citizenry. Therefore, policymakers and educators should encourage and publicise collective efforts to build a stronger community-oriented response to climate change.

Direct experiences with climate change amplify issue salience, underscoring the need for more personalised, relevant and localised communication to activate those currently disengaged. The prevalence of worry and hope suggests a generally positive outlook towards solutions, while feelings of hopelessness and indifference highlight a gap between awareness and perceived efficacy. The strong influence of hope and worry on participation engagement underscores the dual role of fear-based and positive emotions in behavioural activation. Worry, often seen as negative, can reinforce perceptions of risk and urgency. This is supported by the work of Witte (1992) in his extended parallel process model, which suggests that perceived threat combined with efficacy messages can spur protective actions. Conversely, emotional disinterest, as discussed by Norgaard (2006), can dull sensitivity to climate change impacts and hinder proactive behaviour. The challenge of mobilising those who are disengaged or sceptical about the impacts of climate change becomes apparent as this indifference prevents even sporadic engagement.

In the Chinese context, we found that collective efficacy – the belief that a group can work together to achieve climate goals – was a stronger predictor of frequent participation in climate initiatives than self-efficacy – the belief in one's own ability to act. This aligns with the collectivist cultural framework in China, where community and group-based interventions that clarify societal norms regarding climate actions are more effective. Our findings resonate with SIT, which emphasises that people are more likely to act environmentally when they identify with a group that endorses pro-environmental norms (Tajfel and Turner, 1979). Nonetheless, the importance of self-efficacy in fostering frequent participation cannot be dismissed. Without continuous motivational support, personal beliefs may not translate into sustained action. Some respondents reported their unwillingness to compromise their life quality for the sake of environmental protection, a sentiment also considered in developing the bicycle model of CCE in Finland (Cantell *et al.*, 2019). To address this, more targeted communication should be encouraged to reinforce the effectiveness of individual actions and provide clear, actionable steps with ongoing support, empowering individuals to take initiative and realise their role in collective efforts (Leichenko and O'Brien, 2020).

Lastly, our study contributes to the growing body of research on the implementation of CCE in China. The implementation of CCE across China reveals both uniformity and

variations in delivery. CCE is consistently delivered through policy instructions and specific courses nationwide. This standardised approach might limit the promotion of contextual approaches to solving local challenges (Monroe *et al.*, 2019). Mirroring the predominant reliance on government and technological solutions over individual actions, this phenomenon reflects a cultural preference for authoritative approaches in collectivist societies like China. Moreover, SDG 10 (Reduced Inequalities) is particularly relevant here, as economically developed regions tend to have more innovative and interactive CCE practices, such as expert lectures and extracurricular activities, while less developed regions rely more heavily on standardised, policy-driven approaches. This variation underscores the need for more localised, context-specific approaches to CCE in China, particularly in light of its vast geographical and economic disparities. Recently, there has been a growing demand among Chinese students and teachers for interactive and hands-on learning methods, such as climate-change-themed escape rooms (Ouariachi and Wim, 2020) and computer games (Smith *et al.*, 2019), which are key to fostering environmental awareness and proactive behaviours in youth.

6. Conclusion

This study critically examines the dynamics of CCE globally and within China, highlighting the complex relationships between knowledge, attitudes and behaviours towards climate change. Through bibliometric analysis, we highlight the need for greater collaboration and diverse academic perspectives to effectively address the multifaceted nature of climate challenges.

Our findings offer several novel insights into how the KAP model operates within the context of CCE. While climate change concerns are high among Chinese university students and faculty, we observe a significant gap between self-assessed knowledge and actual understanding. This overconfidence suggests the need for a more accurate representation of climate change knowledge.

While much of the existing literature on CCE has focused primarily on scientific knowledge, our study highlights the significant role of climate policies within China's climate education framework. As a country where government-led initiatives are central to driving climate action, the effective dissemination and understanding of climate policies are essential to fostering an informed and proactive citizenry. Policy knowledge was found to positively influence both forms of efficacy, emphasising its importance in promoting climate change mitigation participation. By incorporating policy knowledge into the KAP model, we align with the goals of SDG 4 (Quality Education), as the effective dissemination of climate policies can equip citizens with the tools to take informed action and also fosters empowered communities.

This study also highlights an intriguing finding: students and teachers in the humanities and social sciences tend to exhibit greater concern for climate change than their counterparts in natural sciences. This distinction indicates that contextual understanding – including ethical, cultural and social perspectives – plays a significant role in shaping climate change perceptions and underscores the importance of integrating CCE across all academic fields to build greater concern and motivation. Aligned with the KAP framework, this study reveals that attitudes are crucial mediators between knowledge and behaviour. Although scientific climate change knowledge does not necessarily translate into concern or actions, it can enhance collective efficacy, which in turn bolsters self-efficacy. While self-efficacy increases individual willingness to act, collective efficacy proves to be a more decisive factor in sustaining frequent participation. Furthermore, emotional responses, especially those heightened by direct experiences of

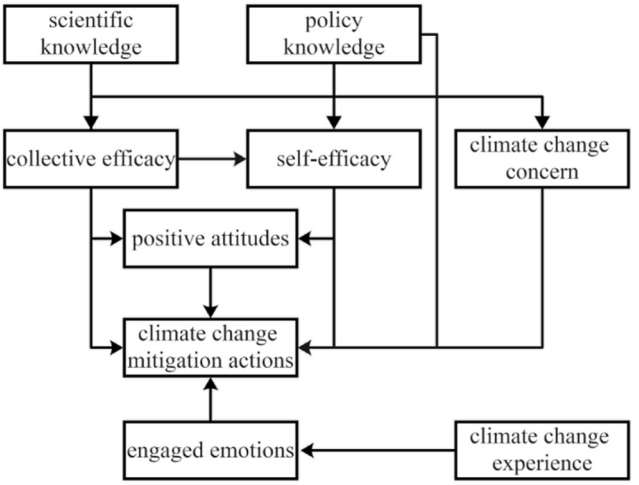
climate change, significantly impact engagement, with positive emotions encouraging action, while emotional disinterest and indifference create barriers.

The study also underscores the uniform delivery of CCE across China, primarily through policy instructions and specific courses. As the global emphasis on inclusive and equitable education grows, it is crucial to develop interactive and localised strategies that can engage students across different regions, thereby supporting sustainable education in line with global goals. This highlights the importance of integrating more comprehensive CCE into formal and informal learning environments, thereby supporting the overarching goals of both quality education and climate action.

The conceptual model developed in this study (Figure 17) enriches the KAP framework by detailing how scientific knowledge and policy knowledge contribute to collective and personal efficacies, shaping attitudes and behaviours essential for climate change mitigation. This model, particularly relevant for collectivist societies like China, emphasises the importance of national policies and community dynamics in motivating actions, offering strategic insights into community mobilisation, thereby supporting the GCC agenda.

6.1 Limitations and recommendations

This study had several limitations. Our bibliometric analysis was confined to the WoS database, which may not have encompassed the full spectrum of CCE literature. This approach also excluded a comprehensive review of the environmental education literature, which may have an intersection with CCE. Future research should expand its scope by incorporating additional databases such as Scopus to achieve a more comprehensive overview. Qualitative methods like interviews or focus groups can be integrated to deepen the understanding of motivations and barriers in CCE. To enhance the robustness of our findings, we recommend a more diverse sample in future studies to validate and refine the observed interactions between variables like age and professional fields.



Source: Authors' own work

Figure 17. Proposed model

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