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Discrepancies in academic perceptions of climate change and implications for climate change education

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Climate change is arguably the most severe threat faced by humanity today. In an attempt to understand how humanity can manage this phenomenon for planetary health, it is fundamental to have an understanding of what it is. This aligns with a critical gap in the extant literature, that is, how different perceptions of climate change among facilitators of learning (in this case, academics) can enable the establishment of a framework of critical consciousness that could boost climate change education and contribute to climate change management. To this end, the study that underpins this paper set out to capture the perceptions of climate change among a selection of academics at a local university in Cameroon. Following a comprehensive analysis of the data, different views on the subject emerged, aligning with scientific, observational, and cultural definitions. Drawing on theoretical insights into critical consciousness, the findings of this study have wider implications for climate change education at universities. A framework is suggested to support educators as they foster critical thinking among learners, as this can facilitate their ability and the wider community to make informed decisions on mitigation and adaptation strategies in light of climate change and the threats it carries.

Climate change is a global issue posing unprecedented threats to populations around the world. Its impacts are felt severely on vulnerable regions and populations, as well as in contexts such as agriculture and the wider environment. Despite this, the Intergovernmental Panel on Climate Change (IPCC) reveals that governments are ill prepared for climate change, and that they lack immediate plans to limit global temperatures below 1.5 °C[1]. To tackle this threat, governments must introduce effective and efficient mitigation and adaptation strategies that help communities move forward responsibly. One of the key measures for adaptation and mitigation is through the fostering of climate change education (CCE) which endows people with relevant knowledge and helps them make informed decisions as they understand climate variability, natural and anthropogenic causes, and the impacts of climate change[2–4]. Previous studies are a testament to this claim as various scholars have demonstrated the importance of integrating CCE into different levels of education to ensure that communities become climate resilient[2,5–7].

To implement successful programs on CCE, it is necessary for educators to have a well-founded explanation and a logical insight into what climate change is about[2,3]. There are existing definitions of climate change, such as it being conceived as a distribution over time for constant external conditions (such as solar radiation), and distribution over time where external conditions vary, and other definitions that look at the atmosphere or change in weather statistics over many decades[8–12]. Such changes that characterize climate change are often due to anthropogenic activities, such as deforestation and burning of fossil fuels, leading to CO2, greenhouse gas emissions and a rise in ocean, land, and atmospheric temperatures[12,13].

Although there are recent extant studies on climate change in the educational context[3,14–16], little is known about how climate change is defined among academics from different disciplinary backgrounds working in higher educational institutions and associated with teaching environmentally related subjects. It is significant to address this for two main reasons: 1) many university academics are at the forefront of empowering young people with a relevant knowledge base to confront climate change, and 2) it is essential to ascertain whether CCE can benefit from varied insights from academics on what climate change represents, or if it would be a cause of confusion among learners. This paper sets out to highlight discrepancies in climate change perception among a group of academics and discusses the implications of these diverse opinions for CCE.

Currently, there is not enough data or evidence to support a uniform definition of climate change among academics. There are studies that discuss perceptions of climate change in different contexts. For example, a study conducted in public and private schools and colleges in Bangladesh

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indicates that teachers are generally aware of the term climate change[17], but there is a difference in opinion on temperatures as they relate to the phenomenon. It elaborates that most private school teachers believe temperatures are rising, whereas most public school teachers believe that they are merely fluctuating. On the other hand, findings in the study suggest that respondents overall agree that extreme weather events such as floods, cyclones, and droughts are occurring more frequently due to climate change. Another study finds that many informal educators are well informed about climate change, but there are some who find it difficult to keep up with the scientific information relating to the subject[18]. In the United States, for instance, a study on high school teachers' perceptions demonstrates they believe that pesticides, aerosols, and nuclear energy contribute significantly towards climate change[19]. Elsewhere, in Norway, pre-service science teachers who have entered the education sector from their prior engagements with the oil industry have a high prevalence of climate change scepticism[20]. This study reveals that owing to their associations with the oil industry, these teachers are less likely to acknowledge the human factors influencing climate change. Eilam[21] posits that "the limited conceptualization of climate change by educators is one of the main problems leading to its poor representation in school education". Furthermore, a misdefinition of climate change may not only have consequences for policy decisions[22] and human actions[23] but also education on the subject.

Although the examples above showcase teachers' perceptions on climate change across different levels of education, there is an identifiable gap in how climate change is understood by academics in universities. Higher education has an immediate role to play in providing key skills for climate change mitigation and adaptation[3,16]. Therefore, this paper presents a study on how this concept is understood in academic contexts, and in doing so, fills an important gap in the extant literature. It achieves this aim by examining the perceptions of the term "climate change" among a selection of academics from a local university in Cameroon, before considering the wider implications for CCE.

Theoretical framework: theory of critical consciousness

This paper sets its foundation in Freire's theory of critical consciousness to discuss the ways in which academics can gain an in-depth understanding of a subject, as well as encourage their students to think and interpret information critically within the framework of knowledge co-creation. Freire defined critical consciousness as a "requirement of our human condition" (24, p. 55). He elaborated that to have a true consciousness, individuals must portray a deep curiosity to reexamine experiences and information that exist as facts in our society. He further explained that individuals will break free from oppressive roles when they confront such biases and the unconscious acceptance of the status quo[24,25]. Consequently, critical consciousness is a learning process by which people can "take action against the oppressive elements of reality" (Ref. 26, p. 4). Therefore, critical education is a key means of elevating not just educators, but also young people, from receivers of standardized knowledge to active participants in change and transformation. In this context, the lecture hall can be seen as a space for co-created learning and teaching, whereby there is no hegemony of knowledge and a plurality of insights are encouraged[27–29]. Through this, educators can also avoid the "banking model" of education[30] where they are seen as the custodian of authentic knowledge and students are only regarded as empty vessels for the imparting of information. This is consistent with the notion of engaged pedagogy, whereby, according to hooks (Ref. 31, p. 202), "students and teachers celebrate their abilities to think critically." So, then, it is not just the story or ideas of the learner that needs interrogating but also that of the educator[31], as both learn, unlearn, and relearn.

For the purposes of CCE, critical consciousness can entail a framework of analytically examining and evaluating climate change issues, adaptation, and mitigation measures. Both educators and learners can achieve a deeper understanding of their realities as they relate to climate change and participate in solutions that are context-specific and holistic in nature. This will not only be seen as empowering with a context of freedom[32] but can also help create climate-resilient communities as knowledge diffuses, leading to behavioral changes and relevant practices. Moreover, for groups that are already dominant in our society – such as professional educators – critical consciousness calls for a necessary insight into one's position in society and role in reinforcing power dynamics and social hierarchy[33]. Therefore, this theory underscores the key potential among both educators and students for their active involvement in implementing a successful CCE program.

Contextual background

This study was conducted at a local university in Cameroon, located in one of the two English-speaking regions of the country and made up of Faculties which include Arts; Health Sciences, Education; Agriculture and Veterinary Medicine, Science; Engineering and Technology, and Social and Management Sciences. The student population is over 12,000, with a diversified staff of about 600 (that is, permanent and part-time).

As climate change is expected to hit hardest on the more vulnerable countries around the world, it is important that Cameroon's practices on climate mitigation and adaptation reflect a comprehensive approach to managing disasters and challenges. The country is home to a vast area of Congo Basin's tropical rainforests. With more than 40% of Cameroon's land being covered by dense rainforests, it can play a crucial role in adapting to climate change across Africa[34,35]. However, this immense natural land is threatened by deforestation and unsustainable agricultural practices[36]. A recent report by the Food and Agriculture Organization of the United Nations[35] further suggests that degradation of the African tropics could have major consequences on rainfall patterns, impacting agriculture and temperatures in the region.

Agriculture is the backbone of the economy of Cameroon, employing up to 70% of the economically active population[37]. This figure suggests that agriculture is crucial for poverty reduction and the development of Cameroon. However, the dependence on rain-fed agriculture disproportionately affects farmers in Cameroon who are experiencing climate variability. Therefore, it is important that the country is prepared to tackle the challenges and risks that are brought on. CCE has the potential to equip communities with the knowledge and tools needed to mitigate or adapt to climate change. In Cameroon, where the vast population is involved in the agriculture sector, it becomes increasingly important that relevant information is communicated to students during learning sessions, for the management of related vulnerabilities to climate change.

Methods

This study employed a qualitative case study approach and data was collected by interviewing academics from a variety of disciplines, including Environmental Science, Education, Agricultural Economics, Social and Management Science, Forestry, Water Resource Management, Gender and Development, Petroleum Geology, Plant Protection, and Geography, and they all had a teaching and research responsibility. In particular, semi-structured interviews were employed as it provided participants with the latitude to articulate their thoughts more freely when compared to structured interviews. An interview guide was used to ask questions to 38 academics at the university who were recruited via a combination of purposive, snowball and opportunistic sampling techniques. These questions focused on: 1) vulnerability to climate change, 2) education for climate change adaptation, and 3) policies and practices that support climate change education in the country. While a set of questions was asked as part of a broader study, this paper is concerned with the following fundamental line of inquiry: What is your understanding or definition of climate change? The in depth semi-structured interviews were audio recorded and later transcribed. Participants consented to take part in the study, which is consistent with the ethical protocol that guided the process. The data captured and analyzed reveal a plethora of views on climate change.

Data analysis

Thematic analysis was used to examine and interpret the data collected in the study. Widely used in qualitative research, this method of analysis

provides flexible approaches to identifying patterns and themes[38]. According to Braun and Clarke[39], thematic analysis helps to systematically interpret and organize patterns across a dataset so that collective and shared experiences can be reported. It is important for the purposes of this paper that interviews collected are analysed to address meaningful insights into education for climate change adaptation. While there are various ways to conduct a thematic analysis, the six-step approach described by Braun and Clarke[40] was chosen as appropriate for this study, given its systematic approach, straightforward application, and relevance. These steps are getting familiar with the data, generating initial codes, searching for themes, reviewing themes, defining, and naming themes, and producing the report[40].

First, the transcripts of the interviews were read and reread, and initial notes were taken to highlight participants' views and experiences. This stage involved reading the transcripts critically and using techniques such as annotations and comments to deepen the understanding of the dataset. After this, coding was carried out manually, and data was broken down into specific labels if it was consistent with the research questions outlined in the interview guide. Using what Braun and Clarke[40] described as a latent level of analysis, this phase of coding also extracted underlying ideas in the transcripts. Next, the coded data were examined to identify broader patterns and similarities, and themes were constructed by grouping codes that shared specific characteristics. During this process, participants' quotations and experiences that were relevant to the codes were collated below their respective themes. By isolating such examples and stories, this phase ensured a comprehensive understanding of the content of the data and guaranteed that the results reflected a coherent analysis[40]. In line with the fourth and fifth step, the themes were reviewed to confirm that they were logical and consistent with the subject of the research and were carefully assigned names[41]. Once this was completed, the data was re-read once again to make certain that the themes finalized were meaningfully capturing the aims of the research overall. The following section discusses the findings as they relate to the questions asked on the definition of climate change. Where participants have been quoted, pseudonyms were used.

Results

A deep insight into the interviews reveals that many academics conceptualize climate change differently from one another. While there are a few commonalities in the way some academics define climate change, it has generally not been defined using a set of similar characteristics or concepts relating to the subject. Therefore, there is a variety of views on what climate change constitutes. As this paper cannot share each participant's responses on the definition or their understanding of climate change, the findings have been grouped into three main themes. These include climate change being defined as[1]: long-term changes in climatic conditions, measured or felt over several years, which have been presented under "climate variation over a long period of time"[2]; climate change defined as a shift in weather conditions and/or the irregularity of climate parameters, which is discussed under "changes in weather patterns"; and[3] a shift from the natural course of the environment to rapid changes and the occurrence of global warming, which have been termed "changes in the natural environment."

Climate variation over a long period of time

Many participants in the study viewed climate change as long-term changes in weather conditions and climate parameters such as rainfall and temperature. Respondents agreed that such changes occurred over a long period of time. One participant stated such a time to be between two to three decades:

"Climate change refers to changes in climate or one of the weather variables that goes on for a long period of time. Principally, what we refer to as climate change is usually associated to a significant change in temperature and rainfall parameters. The changes in such parameters that go on for a long time, spanning two or three decades, is what we call climate change." – MOW (Lecturer in Environmental Science).

Similarly, another participant responded by suggesting the changes felt in the levels of intensity of hot and cold weather over decades is what constitutes climate change:

"When you have the weather of a place and you measure that for more than 30 years, you have its climate. Hence the change in climate will be the average change of what you have been observing. For example, if you put the elements of weather together and you measure that consistently for more than a decade, you have the climate. And, when you start seeing average changes in the degree of hotness or coldness within those decades then you can think of it as climate change." – FOB (Lecturer in Education)

While some respondents resolutely understood climate change to mean variations measured over several decades, others gave no specific duration of time but still agreed it was a "long-term" change felt or measured in the environment. This is represented by one such participant who claims: "Climate change, I will say, is the variation in climatic parameters such as rainfall, humidity and sunshine over time and must not be confused with the weather which simply is the state of the climatic parameter. Climate change is usually recorded in the long-term such that we can evaluate the changes and variation of such parameters over time." – JOA (Assistant Lecturer in Agricultural Economics).

An interesting theme that emerges is that many participants insist we must separate climate change from climate variability. In doing so, many academics compared the two terms considering the duration of years specific to each phenomenon. Some academics defined climate variation as a change in climate measured over a shorter period, while climate change was referred to as a shift measured over 30 years. The participant below looks at climate variation as changes occurring within 5 years:

"I think climate change refers to general change in the climatic conditions of the environment and it might be associated to general changes in temperature, weather, rain falls and changes in seasons. And I think when it is less than 5 years, we talk of climate variation and not climate change." – NOV (Lecturer in Social and Management Science)

Another participant also shared the difference between the two phenomena: "Well, climate change is a change in temperatures and rainfall over a period which is not less than 30 or 25 years. However, below this we have climate variability, and this could be associated to cyclic movements, such as variations in weather patterns within a period of 5 to 10 years. But then this does not mean that the climate is changing." – NOK (Lecturer, Forest and Environment).

Climate change as a concept occurring over 30 years of time, and climate vulnerability as a seasonal shift in weather conditions, was suggested by a different academic: "Climate change could be defined as a change in the weather conditions of a particular place for a long period of time. On average, this could be about 30 years. However, we also have what is known as climate vulnerability which is the change in the weather conditions seasonally or maybe within a year or two years." – ROM (Lecturer, Water Resource Management).

The interviews presented a thoughtful understanding as some academics had strong beliefs about the specific time and duration needed to refer to climate change. The variety of knowledge on climate change's definition does not end here, as many academics perceived it simply as changes in weather patterns. These findings are discussed in the following section.

Changes in weather patterns

Climate change has also been described as shifts in weather conditions and the unpredictability surrounding parameters such as humidity, rainfall, and temperatures. As one respondent simply puts it: "I think we can just associate it [climate change] with changes in temperature, changes in rainfall and humidity." – NOA (Lecturer, Applied Economics).

However, there are other participants who go beyond this definition and talk about the consequences of these shifts manifesting into larger problems for communities such as droughts and famines. One participant explains:

"I can say that from my own understanding based on my personal experiences, climate change refers to fluctuations in climate. This has resulted in impacts like drought, floods, famine, and harsh weather conditions." – AOJ (Lecturer, Gender and Development)

Another participant elaborates on their experiences living in a locality and witnessing how life has been altered due to climate change:

"Climate change is the change of the weather conditions like temperature, pressure, precipitation, and moisture over time. In 2011, when I came to this locality, places were very cold, but later, my first indicator for climate change was when I saw people buying fans. With time places in this locality have become very hot." – OOT (Lecturer, Geography)

Indeed, the impact of extreme weather events is drastically felt in Cameroon. For a country that is so heavily reliant on its agricultural produce, this irregularity in weather patterns causes increased stress upon farmers and local communities. One academic notes:

"Most of our streams have dried off and our crops do not grow the same way as they did in the past. In essence we can consider a combination of one or more of these experiences to denote climate change. The two main aspects of climate change that I have worked on include rainfall and temperature changes. Rainfall pattern is becoming very irregular. The periods rain used to fall have changed, and we also have concerning temperatures. The records of the CDC, Delmonte farms and other weather stations at the University show that there have been on a rise in temperature in the past decade." – AOT (Lecturer, Agricultural Economics)

Still, there are other respondents who viewed climate change as a shift from the normal way of life in the past and mentioned contextual changes in their environment in Cameroon. These impacts of climate change, as discussed by academics below, became a crucial factor in how they understood this global threat.

Changes in the natural environment due to anthropogenic activities

Often associated with human activities, for example the burning of fossil fuels and deforestation, climate change is understood as a shift in the way the environment naturally reacts to rapid or extreme activities, and which sometimes has repercussions due to the way of life of community dwellers. One participant explains it comprehensively:

"It is the alteration in the aspect of the conventional aspect of how the world evolved to have some standard that is compatible for human life and hence, it is the change from that normal standard of the environment. This is because of human activities and even some natural processes which is not conducive to human habitation. In other words, we can say that the environment has been corrupted, regardless if that corruption is by natural activities or man-made." – HOE (Senior Lecturer, Agricultural Extension and Rural Sociology)

Despite extreme weather events brought on due to climate change, some participants expressed some positive impacts of increased temperatures on a segment of the agricultural sector. One academic discusses this in light of climate change's contribution to the increase in crop yield:

"The climate as we know it, is changing at a rate that it is not supposed to. Now you may have some phenomenon like it becomes hotter in some regions, for example, in some of our villages, there are some crops that used to do well only in forest areas, but we discovered that they are now growing even in the grass field because the temperature has changed." – COA (Lecturer, Petroleum Geology)

However, many respondents stand firmly on their understanding of climate change as a system exacerbated due to anthropogenic activities. Many participants agree that climatic conditions have accelerated because of human activities and that they are further worsening the habitats of plants and animal species:

"There has been a consistent increase in global temperatures, and this is due to a lot of anthropogenic activities for example burning of fossil fuels, destruction of forests and environmental pollutions that have speed up temperature rise. The ripple effect is that sea levels are rising, the ice is melting, and we are seeing some [animal and plant] species going extinct. We are also experiencing more wildfires and drought. A brief understanding of climate change is that things are no longer how they used to be; human activities have caused temperature increases, and globally this has resulted in the rise of sea levels and so on." – TOA (Lecturer, Plant Protection)

One academic also related climate change to global warming, referring to increased levels of greenhouse gases in our atmosphere:

"What we understand today by climate change is global warming and this global warming is more because of anthropogenic factors rather than natural forces. We have a lot of greenhouse gases from industrial activities and from agricultural activities, and deforestation which is reducing nature capacity to absorb carbon dioxides. All of these are contributing to increase the amount of greenhouse gases in the atmosphere that are trapping outgoing radiation in the atmosphere and then sending them back to the earth surface leading to climate change." – TOE (Lecturer, Geography and Governance)

It is evident that academics in this study have a deep understanding of climate change; however, their perceptions of the phrase climate change bring forth varying concepts and explanations. Some of these are rooted in science, and others are rooted in cultural contexts and insightful observations. Moreover, their definitions offer a unique analysis of the local experiences, as many respondents discussed the impacts and consequences of extreme weather events on agriculture and the environment. In the next section, we delve into a deeper discussion of the perceptions of climate change from a wider perspective, bringing together views and opinions on the subject as explored in the extant literature.

Discussion

The findings present key insights into academic perceptions of climate change. While academics in the study have a comprehensive understanding of the causes, drivers and impacts of climate change, the questioning asked for their own definition of the subject. This resulted in many academics relating climate change to its scientific explanations, those related to the rise in temperatures and the influence of human activities on the environment[11,12,42]. Meanwhile, others provided a more contextual focus, discussing the impacts of climate change on local groups and communities around them. The latter explanations were elaborated in more detail by the academics who related to climate change as a change in weather patterns and a change due to anthropogenic activities as captured above[11,13]. These participants looked at the consequences of extreme weather events on sectors such as agriculture and natural habitats. In sum, the following three themes are drawn from the findings and discussed below:

- Climate Change Perceptions Aligning with Climate Science.
- Climate Change Perceptions as a Reflection of Cultural Contexts and Observations.
- Implications for Climate Change Education.

Firstly, the perception of climate change that hinge on science can be contextualized in the extant literature and relevant policy documents. For instance, the IPCC defines climate change as "a change in the state of the climate that can be identified… by changes in the mean and/or the variability of its properties and that persists for an extended period"[43]. This understanding is reinforced in the findings of the data, where many academics refer to the long-term factor of climate change and the variations in different weather patterns. As the findings reveal, many academics mentioned measuring or observing changes in the natural state of the environment for periods ranging between 20 to 30 years as an indication of the onset of climate change. Moreover, this specific reference to the time period was elaborated upon by various other academics who differentiated between climate change and climate variability or seasonal disparities. Such responses were rooted in climate science, restating the definitions provided by the IPCC. While there is no consensus on the exact time duration of changes in certain parameters such as the emission of greenhouse gases, global average temperatures or rising of global sea levels to define climate change, the extant literature generally highlights a protracted time range, which can span many decades[11,12,44]. It was not the intention of the study to unpack the veracity of the claims advanced by different authors on the science that underpins climate change but to examine different understandings in an attempt to promote a space for critical engagement. However, the responses given by participants emphasizing human activities and

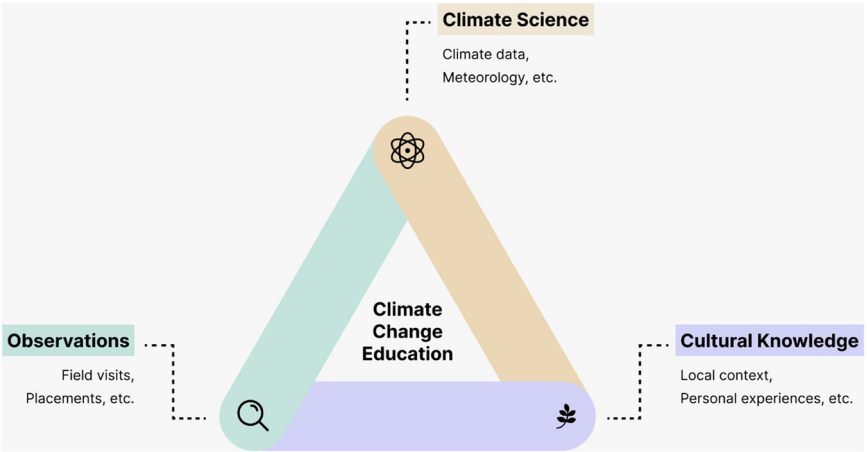

Fig. 1 | A climate change education framework depicting three thematic dimensions. The three thematic dimensions of climate change education touch on observations, depicted with the symbol of a magnifying lens; cultural knowledge, depicted with the symbol of a leaf, and climate science, depicted with the symbol of intersectionality.

their consequences for global temperatures reflect scientific advances in the field of climate change[12,42,45]. The IPCC's Sixth Assessment Report explains how human influence has been a main driver of climate change since the 1800s due to activities like the burning of fossil fuels[46]. Participants discussed deep concern for these activities and viewed climate change with regards to the disruptions caused in the environment due to human advancements.

Other participants provided accounts of how climate change has impacted human lives and the natural environment of Cameroon. Observing effects on streams, rivers and agricultural activities, these participants viewed climate change as a cause of vulnerability. Indeed, the relationship between climate change and vulnerability has been discussed in the past. Schipper and Pelling[47] discuss how climate change slows down the development process in countries as disasters result in the loss of infrastructure and livelihoods. Similarly, climate change has hampered progress towards the realization of the SDGs[4,48,49]. In light of this, the perception of climate change as a factor that increases global vulnerability is undeniable. Embedding this subject in CCE could enhance the role of educators in raising awareness and stimulating an engaged citizenry into mitigating the risks associated with climate change or adapting to its adverse consequences.

Secondly, climate change perceptions as a reflection of cultural contexts and observations can be examined closely. While climate change and its impacts are of the utmost relevance and importance around the world, some perceptions are rooted in personal experiences that include observations of local communities and the impact of certain varying conditions on our livelihood and the natural environment. From the data gathered, we can see that many participants understand the term from the changes they experience or observe around them – for example, risks to local plants and animal species, the impact of prolonged hot temperatures on certain crop production, and the infrastructural damage due to flooding and heatwaves.

Climate itself is often viewed as a statistical phenomenon, one that averages the weather conditions of a particular region[50]. Perhaps because of this, there are expectations for climate change to be understood using a similar approach, such as those including references to meteorology, or reliable trends in weather patterns. Therefore, perceptions of climate change that are derived from observations and personal experiences may be neglected in the development of climate change education. Indeed, it has been argued in the past that observations are connected to time and the memory associated with past events can be faulty, including anomalies associated with the measurement or observation of the planet's temperature[11,23,51]. However, various behavioral researchers have concluded that perceptions shaped by personal experiences involve associative and affective processes that capture the learner's attention[52,53]. Such an approach to understanding climate change is more reflective and these local contexts bring more meaning to adaptation strategies.

As academics are leading climate knowledge in higher education, and disseminating information on this subject, it is important to discuss how their understanding of the subject can translate into CCE. The data in this study gives us an opportunity to discuss whether the diversity of opinions on climate change among academics can foster learning and understanding on the subject or whether it will cause or exacerbate ambiguity on the part of students.

Thirdly, implications of different perceptions of climate change for climate change education abound. Freire's theory of critical consciousness helps us move towards a deeper analysis of our education systems. Keeping the different perceptions of climate change among academics in focus, a holistic CCE framework will allow students and educators to critically analyze and observe the causes, impacts and solutions for this global crisis. Certainly, the inclusion of local challenges in Cameroon is beneficial for students in universities as they learn to engage in dialogues with their educators, and reform mitigation and adaptation strategies. This exchange of knowledge reflects a critical approach to education as identified by Freire[26]. It also opens space for both educators and learners to gain contextual knowledge on the processes and impacts of climate change. This brings opportunities for efficient responses to climate change education because the disruption of hierarchal systems in teaching and learning generates an opportunity for critical pedagogies and valuable knowledge[26,32,54].

In addition to this, the emphasis placed on the scientific knowledge and reasoning behind the advent of climate change by academics is a useful guide for all educators on implementing CCE in their classes. Climate change has been understood using different approaches in the past. However, areas of natural sciences, meteorology, atmospheric sciences, and oceanography have been working consistently to study and disseminate information on the subject[55]. By bringing multi-disciplinary approaches into CCE, we can look forward to a "collective human action" that aims to bring normalcy around the earth, and to minimize damages[56]. Without a doubt, the teachings of climate change rooted in scientific information act as a valuable approach to encourage the social action needed to combat this threat. Educational institutions may find it useful to implement the different perspectives of climate change into their CCE programs and examine how their students benefit from an integrated and interactive framework, illustrated by Fig. 1.

The framework suggested in Figure One brings to the fore the three thematic dimensions associated with how the research participants perceived climate change, notably as a scientific, cultural, or observable phenomenon. These different dimensions of understanding climate change, as discussed by academics in this paper, constitute practical elements that can be captured within a successful CCE program. Collectively, they also represent multidisciplinary perspectives whose integration can help in the development and advancement of solutions to climate change[55,57]. It can be argued that advancing insights on climate change should not solely be focused on scientific knowledge but also on the associated local challenges and impacts upon communities, as well as the broader socio-economic

issues faced at a global scale due to the crisis. Therefore, a successful CCE program must incorporate scientific knowledge, cultural insights and local contexts that are observable, which can include field visits or placement activities (see Fig. 1). This will shape a holistic understanding of the subject as educators promote critical consciousness by engaging students in processes that engender critical reflection, as they probe timely adaptation and mitigation strategies for communities. This framework is supported by a previous study that concludes perceptions of climate change are shaped by different elements, including personal experiences and statistical models[50]. Knowledge of climate change may not only be constructed in the classroom via the guidance of educators who possess scientific insights but can also include cultural and place-based elements contextualized in field visits. Promoting an engaged or experiential pedagogy, whereby students undertake placement opportunities or field trips, can provide contexts where certain assumptions are challenged by the realities on the ground or lived experiences of people in the local community, which can then help to guide solutions for adaptations or mitigation that are context-specific and pragmatic in their approach.

CCE, which involves diverse perceptions and opinions on climate change, supported by scientific insights, cultural knowledge, and observation (as illustrated by Fig. 1), can also use critical and analytical means to derive useful knowledge on a climate-related phenomenon. For educators, this can mean teaching students to transgress the boundaries that confine them to narrow insights and embrace multiple ontologies on climate change, as this can offer pathways to contribute to new approaches or hypotheses for mitigation and adaptation[58]. Such a pedagogical approach can benefit from wider and more comprehensive information for critical engagement as opposed to a uniform perspective on climate change, which may be heavily Eurocentric or Westernized and devoid of cultural and indigenous insights which are relatable.

In conclusion, climate change is arguably the most severe threat faced by humanity today. To highlight how humanity can manage this phenomenon for adequate planetary health, it is fundamental to understand what it is. To this end, the study that underpins this paper set out to capture the perceptions of climate change among a selection of academics at a local university in Cameroon. As CCE is becoming a vital tool to build the capacity of present and future generations towards sustainable climate actions[2,3,59], the perception of academics who may be considered facilitators of learning on the subject can present a starting point for critical reflection, deeper understanding or even knowledge management[60].

The thematic analysis of the data captured depicted different views about climate change expressed by the participants. While some participants perceived climate change as climate variation over a long period of time, some suggested it was changes in weather patterns and others pointed to changes in the natural environment because of anthropogenic activities. It can be argued that these findings aligned to elements of climate science, cultural contexts, and observations. Drawing on Freire's insight into critical consciousness, the findings of this study have implications for climate change education at universities. A framework has been proposed to aid educators in their attempt to foster an engaged pedagogy with the effect of engendering critical thinking as they collectively (with learners) attempt to define the subject. Any definition of climate change arising from critical consciousness in a learning community must be inclusive and relatable. The attendant consequence of this is that it can facilitate the ability of both educators and learners to make informed decisions on mitigation and adaptation in light of climate change and the threat multiplying effects it carries.

A key shortcoming of this study is the fact that it drew from a single case study, which limits generalization. However, the paper fills a critical gap in the extant literature on how different perceptions of climate change among educators can enable the establishment of an impactful framework that could boost climate change education, contribute to critical consciousness, and appropriate actions. The study's original contribution lies in the proposed framework for climate education that draws on the interaction between the dimensions of science, culture, and human observation.

Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Competing interests

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