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Climate Change Education in National Curricula: A Scoping Review of Climate Change Epistemology, Educational Policies and Implementation

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ACRONYMS

CC	Climate Change
CCE	Climate Change Education
CCESD	Climate Change Education for Sustainable Development
CE	Climate Education
CfE	Scottish Curriculum for Excellence
DESD	Decade of Education for Sustainable Development
DRR	Disaster Risk Reduction
DRRE	Disaster Risk Reduction Education
EE	Environmental Education
EES	Education for Environmental Sustainability
ESD	Education for Sustainable Development
ESE	Environmental and Sustainability Education
EU	European Union
GAP	Global Action Programme
GCC	Global Climate Coalition
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-Governmental Organisation
NGSS	Next Generation Science Standards
OECD	Organisation for Economic Co-operation and Development
SDGs	Sustainable Development Goals
SE	Sustainability Education
SE	Sustainability Education
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
US	United States
USA	United States of America

EXECUTIVE SUMMARY

The scoping review presented hereby provides insights into the state of play regarding climate change (CC) education implementation in national policies and school curricula. It presents some critical analysis of the literature, and suggestions for strategic directions. This study applies a scoping review approach for selecting and analysing relevant literary sources. The scoping review methodology was chosen due to its usefulness in comprehensively summarising and synthesising diverse types of literature in emerging fields, with the aim of informing policy development. Two types of publications were retrieved for this review. The first type was peer-reviewed articles published primarily between 2010 to 2022. The second type of output includes grey literature, consisting primarily of policy documents and reports developed by international, regional, and national bodies, as well as third sector organisations. Following screening, selection and inclusion, a total of 191 publications were thematically analysed.

The findings of the scoping review are organised by three main themes, as follows:

1. Critical examination of CC epistemology and contextualising CC education in Curriculum Theory and the sustainability education agenda,
2. Applying international comparative evaluation of CC presence in national curricula and identifying critical implementation gaps, and
3. Critically examining the role of behaviour in CC education literature and proposing to reframe behaviour conceptualisation.

In what follows, the findings concerning each theme are discussed sequentially, followed by presenting a set of recommendations.

Climate Change Epistemology: Contextualising Climate Change Education in Curriculum Theory and the Sustainability Education Agenda

Putting in Context: Curriculum and Learning

Curriculum can be defined broadly as “anything that schools do that affects pupils’ learning” (Ross, 2000, p. 9); or it may be defined narrowly “as specialized knowledge organized for transmission” (Young, 2004, p. 198). It is different from everyday knowledge, in enabling students “to acquire knowledge that takes them beyond their experience, and they would be unlikely to acquire it if they did not go to school” (Young, 2014, p. 196). Over the past 100 years, curricula across the world are becoming increasingly universalised.

Two types of curricula are currently dominant, *content-based* and *capacities-based* curricula. The *content-based* curriculum is based on disciplinary subjects. In this curriculum some subjects are ranked high in the curriculum hierarchy, and some are ranked low. Subjects with high status tend to be core, have benchmarks and standards of evaluation, whereas low-status subjects, are cross-curricular, "unbounded and non-classified" (Ross, 2000, p. 111).

The *capacities-based* curriculum is organised around specific capacities deemed as needed by the society or the economy. Subject boundaries tend to be weaker since the emphasis is not on the academic worth of the subjects, but rather on whether the subject can deliver skills and capacities deemed worthy. The *capacities-based* curriculum is often associated with the neo-liberal individualistic worldview and the capitalist economy, emphasising the production of work-ready citizens through the development of personal capacities.

The *capacities-based* curriculum received various critiques, including: (i) it draws attention away from what students should learn to what they should become, thus students are becoming objectified in the sense that they are expected to operate in a pre-determined way (Biesta & Priestley, 2013); and, (ii) it diminishes the role of knowledge and undermines learners' entitlement for "powerful knowledge" (Young, 2013, p.101). Currently, various curriculum reforms are reinstating the centrality of knowledge in the curriculum (Roberts, 2021).

Effective curriculum development needs to take in account the structure of knowledge and knowledge acquisition. Knowledge acquisition essentially "involves a change in long-term memory along with mechanisms for retrieving ideas from long-term memory. If nothing has altered in long-term memory, nothing has been learned" (Commission on School Reform, 2020, p. 10).

Research in the fields of epistemic cognition, epistemic emotions, and cognitive psychology (e.g., Chinn & Buckland, 2011; Muis et al., 2021; Sweller et al., 2019) provide useful information about the brain architecture and information processing. One thing that stands out clearly across these fields of research is that for knowledge to be processed effectively it needs to be systematically structured and organised. Disciplines stand out as the most effective form of knowledge organisation.

Some educational ideas are not substantiated by appropriate research and hinder curriculum development. These include: (i) future thinking. This term is unhelpful because our brains are essentially predicting machines, and the human brain is only capable of making predictions into the future, based on past learnt experiences (Barret, 2020); and (ii) holistic learning. Learning is never holistic and always holistic. It is never holistic because information needs to be carefully selected, broken down and processed discreetly, before it is transferred from the working memory to the long-term memory (Sweller et al., 2019). It is always holistic due to the interconnectivity of past and

present experiences, emotions, thoughts bodily input and environmental input, in the process of learning.

The Cognitive Load Theory may be useful in pointing out skills that are teachable and those that are less teachable. Skills associated with *biologically primary knowledge* are generic and can be acquired independent of disciplinary knowledge. Contrarily, *biologically secondary knowledge* skills are heavily discipline-specific (Sweller 2015, 2016). Importantly, learning always involves a combination of primary and secondary knowledge. However, what is critical to note is that while the secondary knowledge is teachable, the primary knowledge that is concurrently involved in learning, is mostly not teachable (Sweller et al., 2019). Similarly, epistemic cognition, epistemic emotions, and critical thinking are all engulfed in complex relationships during learning and there are no practical ways for distinguishing among them in the teaching and learning processes (Muis et al., 2021).

These findings suggest that CC curriculum developers need to focus on developing a curriculum based on disciplinary-specific knowledge and skills, rather than on generic skills, which teachers have minimal control over their acquisition. In this context the Scottish Commission on School Reform (2020) reminds us that "skills do not exist in a vacuum but depend upon knowledge. This applies even to so-called thinking skills. It is not possible to think without thinking about something" (Commission on School Reform, 2020, p. 10).

Furthermore, by developing high quality CC curriculum that is conceptually challenging and intriguing, the process of teaching and learning will inevitably involve application of a range other generic skills, emotions, bodily and behavioural responses. However, while curriculum has little control over these secondary affective and physiological aspects, it has much to say on creating the circumstances and opportunities that allow them to arise effectively.

Climate Change as a Body of Knowledge

What is climate change? Is it a discipline, a concept, an idea, a theme, an event, a crisis, a process or an aspiration? Answering this question is critical for curriculum development, because if we don't know the nature of the knowledge that we are teaching, how would we know the appropriate ways for including it in the curriculum, determining learning outcomes and developing assessment measures?

Examination of the literature reveals a range of CC epistemologies. Most commonly CC is described as multidisciplinary. Other epistemological descriptions include the following: (i) CC forms part of science literacy; (ii) CC as a geographical process; (iii) CC as an environmental issue; (iv) CC an energy systems issue; (v) CC as capacities within ESD; (vi) CC is a topic or theme of ESD; and more.

CC is associated with multiple terms. The review identified 21 different terms. The multiple terms arise as each term pushes aside the former term, claiming that the new term is more inclusive of issues or has more emphasis on certain issues. However, this neologism excludes any real conversation from taking place regarding what this knowledge actually means.

Characterising CC as multidisciplinary does not qualify as an appropriate epistemic characteristic of CC knowledge, when presented as a sole characteristic of CC. This is because most concepts, ideas and disciplines are essentially multidisciplinary. This descriptor acts as an obstruction, as it gives the false idea that we have characterised the nature of CC, where in effect, we have not.

Eilam (2022) made a case as to why CC should be conceptualised as a discipline, making the argument that CC demonstrates a wide range of characteristics typical to disciplines, including for example: being specialised knowledge in structure and purpose; and the concepts within the disciplines are linked. CC also demonstrates Schwab's (1967) structural aspects of disciplines.

When considering the delivery of CC education within the school system, one cannot but wonder about the epistemological uncertainty and vagueness surrounding CC. For most other curriculum contents deemed important and ranked highly in the curriculum hierarchy, such as Mathematics, Science and Literacy there are allocated subjects, teaching hours and specialised teachers. So why is it that only CC has gained the unfortunate fate of being fragmented, torn apart and dispersed across the curriculum under the banner of multidisciplinarity? This is clearly not the case for most other multidisciplinary subjects, such as Geography, Civics, History and more. Even more puzzling, is the lack of theoretical rational or empirical evidence for supporting this unusual approach to CC curriculum development.

Conceptualising Climate Change in the Context of Education for Sustainable Development

The review suggests that from an epistemological perspective, Education for Sustainable Development can best be defined as an: **Agenda for solving the world's major problems as they are understood at any given time**. However, this agenda is not fit to form a basis for CC curriculum development.

The analysis of a section of Mulvik et al.'s (2022) report to the European Commission, demonstrates an epistemological chaos and conceptual absurdities in relation to conceptualising CC in the content of sustainability education. Further examination of UNESCO's and some of UN's initiatives reveal epistemological ambiguity, inconsistencies and even contradictions, in relation to conceptualising CC in the context of education for sustainable development (ESD).

Chronological evaluation of ESD conceptual development reveals the following:

- The UN became involved in environmental education (EE) in 1977. The Tbilisi Declaration sets out the scope of EE to include environment, economy and society (UN, 1977).
- In 2002, in the World Summit on Sustainable Development in Johannesburg, the name EE was officially changed to ESD. UNESCO was designated to lead the United Nations Decade of Education for Sustainable Development (DESD) (UNESCO, 2020). Fifteen Strategic Perspectives were outlined as constituting ESD.
- In 2012 at the Rio+20 conference on Sustainable Development, an additional perspective was added: Sustainable Consumption and Production.
- In 2015 with the adoption of the 17 Sustainable Development Goals (SDGs) and Agenda 2030 for Global Transformation, ESD conceptualisation shifted once again, to include a new set of themes/perspectives, with little resemblance to the original set. In 2020 (UNESCO, 2020) ESD was announced as an enabler of all the SDGs.
- Examination of the ESD indicators for Target 4.7 of SDG4 Quality Education; Target 12.8 of SDG 12 Responsible Consumption and Production, and Target 13.3 of SDG 13 Climate Action, reveals that these indicators are practically ineffective in measuring their targets and in effect, they are not being measured.

ESD is not fit to form a basis for curriculum development for the following reasons:

- It does not represent any organised body of knowledge. While ESD is organised around problems, there is no sense in organising the curriculum around problems, because problems tend to change over time and are not capable of supporting effective knowledge construction.
- ESD is an agenda aiming to utilise education for the purpose of societal transformation, in what seems to be an attempt to hijack the education systems for achieving its prescribed agenda as an end goal.
- González-Gaudiano (2005) described ESD as an elusive thematic group of issues, randomly allocated into a shared space, as empty signifiers. There are no rules that govern the relationships between the various ESD themes and therefore they can be understood differently and even contrarily by different people.
- ESD was criticised for: (a) directly cultivating the neo-liberal stance in relation to the economy (Stein et al., 2022); (b) its instrumental and anthropocentric approach to nature, where the dominant ESD view conceives nature as a 'resource' (Kopnina, 2012; Sauvé, 1996); and (c) creating opportunities for corporates and interested actors to manipulate this

agenda to support their interests and undermine efforts to seriously address CC (Hove, 2004 in Stein et al., 2022; Waldron et al., 2019).

Comparison of ESD knowledge and CC knowledge

ESD knowledge is ephemeral, anecdotal with no rules and concepts of organisation. Contrarily, CC has evolved over the past 100 years as an organised body of knowledge with rules for determining claims of truth, and well-defined concepts and principles that govern the knowledge production.

The absence of such governing rules and principles is not a minor issue in ESD. Rules determine truthfulness. That is, claims of truth are judged by the extent to which they adhere to the consensual rules and principles of the field of knowledge. In the absence of rules, claims for truth cannot be refuted or verified, thus leading to a relativist worldview, where all claims are equally valid. Such is the case for example, when BP, a company responsible for the emissions of 340 million tonnes CO_2 equivalents per year in 2020 (Global Data, n.d.), can safely claim on their website "Our purpose is reimagining energy for people and our planet. We want to help the world reach net zero and improve people's lives" (see https://www.bp.com/en/global/corporate/who-we-are/our-purpose.html). Under the ESD framework, such claims are un-refutable, and may be accepted as truths.

While CC knowledge is expanding and being continuously revised, in a typical disciplinary characteristic, the basic concepts that constitute this body of knowledge present relative stability over time. No such stability can be attributed to the various ESD challenges. Not even at the basic level of terminological stability.

Tensions concerning CC implementation

CC conceptualisation with ESD is at odds with CC conceptualisation by scientists. The peak body for informing the evidence-based knowledge concerning CC is the IPCC (IPCC, n.d.), which is often found to be at odds with the ESD approach to CC.

Kranz et al. (2022) note that at school CC discourse tends to ignore the IPCC. There is evidence to suggest that ESD is muddling the evidence-based facts. This is exemplified by the different ways in which IPCC defines the term mitigation, and ESD literature defines mitigation. While the first definition is factual and science-based, the latter is value-laden, presenting unsubstantiated 'facts' as claims of truth.

There is an inherent unresolvable tension between content-based curriculum and ESD. This is because for the content-based curriculum to work, the teaching must be organised around knowledge. Since ESD is not a knowledge-based agenda, but rather a problems-based agenda, it may

become extremely difficult to fit this agenda into the curriculum, particularly when it calls for reorienting the curriculum (UNESCO, 2017). In essence the ESD agenda delegitimises the existing curricula.

Overall, it appears that CC association with ESD forms a major obstacle for effective CC curriculum development (Blum et al., 2013). Selby and Kagawa (2010) call on policy developers to steer away from conceptualising CC as a topic of ESD. The broad evidence suggests that CC curriculum, is more likely to fulfill its purposes effectively when organised around knowledge, not when organised around agendas and periodic challenges, as is the case of the ESD and SDGs agendas.

Comments Concerning Climate Change Education Discourse

The Cross-Curriculum Approach. A cross-curriculum approach is the most advocated approach for implementing CC education. However, empirical evidence suggests that this approach is not working as well as expected, and no evidence-based theoretical frameworks have been presented thus far to suggest otherwise. Contrarily, the low chances of succeeding can be deducted from a range of theories, thus suggesting that this approach is unlikely to meet the expectations in future applications.

Discourse of 'Learning'. ESD discourse emphasises learners and learning. For example: "What ESD requires is a shift from teaching to learning" (UNESCO, 2017, p. 7). According to Gert Biesta (2022) the discourse of *learnification* is derived from the neo-liberal market-driven educational reforms, that shift attention away from the critical questions of content, curriculum, teachers, and teaching, making these critical aspects of education invisible. This comment draws attention to the importance of focusing on the curriculum, teachers, and teaching, rather than on the tacit aspects of learning. Simply put: the curriculum needs to focus on what it is giving to the students, rather than on what the students will do or not do with these educational gifts.

Transformative Education. UNESCO unapologetically calls for transforming individuals, schools, and societies. This re-education agenda permeates the organisation's publications. At the surface level, the idea that students should be "transforming their own behaviour" (UNESCO, 2017, p. 7) seems alarming, as it suggests that students are essentially sinners that need redemption. The literature provides various obscure definitions for transformative education. These definitions on one hand seem to describe what education does anyway, and on the other hand transformative learning calls to disrupt education. Similarly, there is also inconsistency in the fact that on one hand, there is wide agreement that the role of schools is to provide students with the best knowledge, the best skills, the best values, and overall, the best experiences that societies can offer; and on the other hand, transformative education, puts forward the expectation that students will undercut their learning,

and in essence reject what they have learnt. More so, the transformation idea at its essence suggests that schools are doing a bad job and that students should not be taking in what schools have to offer. This leaves us questioning: If schools cannot educate well, who can?

Considering the idea of 'think globally—act locally'. Since the early inception of EE, the motto 'think globally and act locally' found much credence among educationists. Research examining whether framing CC as a local problem promotes action, suggests the opposite. Four lines of evidence were presented, each using a somewhat different theoretical framework, yet all reaching the same conclusion. Consequently, proximising CC as a mean for motivating students to take action, would most likely be counterproductive (Brügger et al., 2015). However, this applies only when the construction of local knowledge is purposefully used for serving the behavioural goal. Once education releases itself from the aim to change the students' individual behaviours, the risks associated with proximation no longer apply. In other words, when localising CC is dissociated from expectations that students will change their bewhaviour, the problem of being counterproductive no longer exists. Therefore, educators should be mindful of not crossing the lines by utilising the delivery of local CC knowledge as a means of serving behavioural change purposes. Say from now: 'Think globally—think locally'.

Cognitive Learning, Socio-Emotional Learning and Behavioural Learning. ESD literature presents a distinction between three separate domains of learning, cognitive, socio-emotional and behavioural learning. The literature suggests that by addressing these three aspects in ESD it would be possible to achieve behavioural changes among students, and in turn a more sustainable world. There is no evidence to support any of these assertions. First the idea that the role of education is to train students to change the world, is ethically problematic, as the role of education should be first and foremost to educate students. Secondly, current research suggests that there are no distinguishable brain processes that differentiate between cognitive and emotional learning. All learning involves complex integrated processes of epistemic cognition, epistemic emotions and embodied (physiological and behavioural) cognition. These cannot be taught separately, acquired separately or assessed separately. Furthermore, much of the socio-emotional and behavioural learning, tacitly involves biologically primary knowledge, which cannot be taught and difficult to asses.

Survey of Climate Change in National Curricula

This chapter presents national curricula survey results, obtained from approximately 194 countries across the globe. For the purpose of curricula review both primary and secondary sources were used. The primary sources consisted of direct analysis of curricula, with a focus on the NGSS, New Jersey curriculum and California curriculum. Whereas the secondary sources consisted of

international comparative analyses of CC in national curricula, and surveys of countries' CC education policies. Additionally, primary sources analysis was conducted in the context of my participation in the cross-country comparative analysis, conducted by Dawson et al. (2022). The main findings are summarised in what follows.

Climate Change Presence in National Curricula: Lack of Depth Breadth and Conceptualisation

- CC is mentioned in the curricula of approximately 53% of countries (UNESCO, 2021a, b).
- CC commonly appears in curricula as a term only, with no associated content. CC is mostly addressed in a shallow way, lacking depth and breadth, characterised by fragmentation. Parts of CC tend to be dispersed, appearing under different topics in incomplete ways, often appearing as an example for some other topic, without further discussion (UNESCO, 2021a,b).
- There is lack of consistency in relation to CC conceptualisation within curricula and educational policy documents. CC education may appear as separate from ESD, or it may appear as a topic of ESD, EE or SDG (Laessøe & Mochizuki, 2015). In curricula documents, CC is often subsumed under various topics, in different ways. For example: CC may be subsumed once under science, and a second time under the environmental theme in science. Or once under geography and a second time under the sustainable development theme within geography (UNESCO, 2021b).
- The National Center for Science Education and the Texas Freedom Network Education Fund (2020) critiqued CC presence in the science curricula of the 50 USA states, in relation to: (i) promoting false debate about CC; (ii) avoidance of some curricula to clearly name "climate change" when addressing CC issues; and (iii) muddling the science, by using ambiguous wording and suggesting unclear evidence.
- CC in the Next Generation Science Standards (NGSS) lacks epistemological clarity, coherency and consistency. There is also lack in terminological consistency, and clear scoping of CC contents.

National Strategic Frameworks and Climate Change curricular Planning

- Most educational policy documents are lacking in: CC education action plans; curriculum frameworks; implementation mechanisms; allocation of responsibilities; and monitoring and evaluation. The educational policies also lack engagement among policy makers and critical stakeholders. (Dawson et al., 2022; Laessøe & Mochizuki, 2015).

- In states and countries that include CC in their curricula, there is a conspicuous lack in frameworks, outlining a clear rational and theoretical underpinning, justifying, and explaining their approaches to CC curriculum development and inclusion in school programs. There is lack in weighing out of alternative options for CC inclusion and using best-practice evidence for guiding CC curriculum development and implementation.

Approaches to Including Climate Change in the Curriculum

- CC education is reported to be mandated in core curriculum only in Italy (UNESCO, 2021b), Israel, Indonesia (Dawson et al., 2022), and New Jersey.
- While most educational documents advocate for cross-curriculum inclusion, CC is rarely addressed in a cross-curriculum approach (UNESCO, 2021a,b).
- In countries were CC is addressed at some depth, this would mostly occur in science and geography (UNESCO, 2021a,b).
- In no country CC appears as a curricular subject on its own right.
- CC appears as a standalone topic in Ontario, Canada Year 10 science, and in Indonesia Year 7 science. (Dawson et al., 2022). In New Jersey Curriculum CC appears as standalone topic in both Social Studies and Science in year bands 6-12.
- In NGSS CC is incorporated as a recommended concept within the disciplinary core ideas and in most of the crosscutting concepts. However, the topic of CC appears explicitly only in Earth and Space Science in one standard in middle school and four standards in high-school (NGSS Lead States, 2013).

CC Scope of Contents and Curricular Organisation

- None of the analysed curricula presented a clear scope of CC content knowledge, thematic organisation of the knowledge, and progression points for concept development in relation to Year levels.
- CC science contents in the NGSS include: CC mechanisms; analysing large-scale data, developing arguments from evidence, characterising uncertainty, making predictions about the future, and linking Earth's physical and biological processes at multiple scales. The socio-economic, governance and policy, and ethical aspects are insufficiently addressed (Johnson & Anderson, 2017)

Climate Change by Year Levels

- Specific CC contents begin to appear in most national curricula in the middle years. In most curricula CC science is comprehensively addressed in Year 10 and above (Dawson et al. (2022).
- In NGSS CC does not appear as a topic (or even as a term) prior to middle school. In primary school it is specifically and intentionally excluded from the curriculum.

Disaster Risk Reduction

- Disaster risk reduction (DRR) related to CC is missing from most national curricula.
- DRR is addressed in the NGSS in Years 3-12. The analysis revealed that DRR in the NGSS lacks the critical aspect of "learning and practicing safety measures and procedures" (UNESCO &UNICEF, 2014, p. 11).

Inter-Ministerial Collaborations in Curriculum Development

- Inter-ministerial collaboration, such as collaborations between Ministries of Education and Ministries of Environment, was reported to have a positive impact on developing a mandated CC curriculum (Laessøe & Mochizuki, 2015; UNESCO, 2021a,b).

Recommendations

CC Epistemology

1. CC curriculum needs to address the epistemic question related to the nature of CC knowledge.
2. It is suggested to consider conceptualising CC as a discipline.
3. CC curriculum needs to rely on a wide range of evidence-based educational theories and proven practices, not on floating fashionable ideas.
4. CC needs to be addressed, using consistent and unified terminology. The field requires one name only. The term used by IPCC is *Climate Change*. This is the most scientifically accurate name that should be used.

Approach to Inclusion

5. There is indication that best-practice for CC inclusion in the curriculum is by developing a dedicated CC subject.
6. The dedication of a subject assists in increasing the curricular status of CC. However, higher

curricular status may also be achieved by determining benchmarks and standards of achievement, and assessing through assessments that 'count', meaning deemed important.

7. The cross-curriculum approach for implementing CC is less likely to work for a range of reasons concerning the nature of knowledge, teachers and teaching. Any decision to apply this approach needs to be accompanied by careful monitoring and evaluation, to allow corrections and modifications on the go, and ensure that resources are well allocated and spent. It is recommended that at the onset of the cross-curriculum program, the Ministry would determine a set of indicators for evaluation, and collect a range of appropriate data from principals, teachers and students for assessment.
8. Develop clear rationale explaining the approach to CC inclusion in the curriculum, using evidence-based argumentation.

Curriculum Organisation

9. Develop rational for CC curriculum organisation and thematic progression across year levels.
10. CC curriculum needs to put CC knowledge at the centre and identify domain-specific skills.
11. For effective learning of CC, the content knowledge needs to be systematically organised.
12. Develop a thematic organisation of CC contents.
13. Identify key concepts in each theme.
14. Develop progression points and achievement outcomes, by themes and year levels.
15. Plan for thematic integration of concepts at specified progression points along the learning sequence and their assessment.
16. Carefully consider the appropriateness of CC concepts in relation to student year levels.

Teaching and Learning

17. Teachers and teaching need to be made central to the CC curriculum by cultivating teacher pedagogical content knowledge (PCK) and professional identity in CC education.
18. All knowledge acquisition involves epistemic cognition, epistemic emotions, social and physiological processes in complex interactions. Some are teachable, and some are not. The curriculum needs to focus on knowledge and skills that are teachable, while creating a rich learning environment that allows for the tacit learning processes to arise and interact in the process. Pedagogies such as experiential learning, inquiry-based learning, and social interactions with others, assist in cultivating such environments.

Climate Change versus Education for Sustainable Development

19. There is clear evidence suggesting to dissociate CC curriculum from ESD.
20. ESD is defined in this report as an 'Agenda for solving the world's major problems as they are understood at any given time'. For a range of reasons, while the ESD agenda may be an add-on to the curriculum, it cannot dominate or substitute the curriculum. Accordingly, ESD is not fit to form a basis for CC curriculum development.

Global versus Local Climate Change

21. There is an intrinsic value in teaching CC as both a global phenomenon, as well as its manifestation in the local context. Evidence suggests that pedagogies which contextualise knowledge locally in ways that are perceived as relevant to students, support students in processing and retaining knowledge. However, proximising CC with the aim of increasing behavioural change is counterproductive and may lead to apathy or CC denial.
    Collective CC action may be applied as an effective pedagogy for proximising CC. However not the other way around. Meaning, that proximising CC should not be used to promote action on CC.

CHAPTER 1. INTRODUCTION

The philosopher Bruno Latour, when addressing the immense challenges involved in transitioning humanity into living in climate change (CC), "a land so different from nature" (Latour, 2021, p. 18), posited: "Adapting? Adjusting? Coping? All sorts of words that mean how to live in the ruins" (p. 20). In his further contemplations about this old, but new hostile land that we are now entering, Latour ponders: "Look at what is necessary for landing one robot on a Mars mission: imagine what it will require to land eight billion people on Earth!" (p. 20). Inspired by Latour's provocation, this report puts forward the aim to examine what it would take to educate all young Israelis to live and thrive in an era of CC. An era of uncertainties, frequent disasters, and social-economic-environmental instabilities, where tipping points are crossed—leading to the unknown.

The scoping review presented here provides insights into the state of play regarding CC education implementation in national school curricula. It presents some critical analysis of the literature, and suggestions for strategic directions. The process of developing a CC curriculum invites us to embark on a journey of epistemological, ontological and axiological clarifications concerning the nature of CC and the nature of education. It raises moral questions regarding the ways we present CC to students and what is it that we are asking them to learn and perform. Specifically, there is a need to unpack the two key terms constituting this important enterprise. These are: *climate change* and *curriculum.* Critical questions concerning CC include for example: What is CC as a body of knowledge? What is the scope of CC contents? What are the boundaries of this knowledge and how is this knowledge derived? In relation to curriculum, this process invites us to think about questions such as: What is a curriculum? What are the constituents of a curriculum and how are they related to each other? What are the processes by which a body of knowledge can be effectively organised for delivery? What are the relevant considerations in organising units of knowledge across year levels? What forms of delivery may allow units of knowledge to connect and support the acquisition of the learning outcomes (i.e., CC literacy) among students? The answers to these questions and others are inherently connected and nested within broader theories of cognition, developmental and social theories, teacher pedagogical content knowledge and other theories that have bearings on the schooling enterprise.

In other words, the coming together of *curriculum,* and *climate change* body of knowledge into one framework, requires complex integration of diverse evidence-based theories and practices, all working together to create an effective CC curriculum, capable of meeting its set of objectives. Eventually, an effective curriculum is characterised by scholarship, dynamism and change, debate and research leading to further growth and ongoing development.

CHAPTER 2. RESEARCH AIMS AND QUESTIONS

The aim of this scoping review is to systematically map out international approaches to CC curricula development. Specifically, this review is guided by the following questions:

1. What are the epistemological approaches for conceptualising CC and CC education?
2. How is CC education reflected in national policies concerning CC?
3. What are the approaches for including CC in the curriculum?
4. What can be learnt from national CC curricular surveys regarding the contents, scope, standards of assessment and overall approaches to curricular development?
5. What is the scope of CC knowledge, skills and learning outcomes according to literary sources?
6. What are the pedagogical approaches for implementing CC?
7. What is the role of disaster risk reduction in CC curricula and how are countries and states preparing schools and students for disaster risk reduction?
8. What is the role if behaviour in CC education?
9. How is climate anxiety addressed in the literature in relation to CC education?
10. What examples may be drawn from the literature for addressing teacher preparedness and resources development for teaching CC?

CHAPTER 3. METHODS

This study applies a scoping review approach for selecting and analysing relevant literary sources. Colquhoun et al. (2014) defined the scoping review methodology as: “a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting and synthesizing existing knowledge” (p. 5). The methodology, originally developed in health sciences, is now commonly used in social sciences, often prefered over the more traditional systematic literature review, due to its flexibility and affordances in relation to synthesizing a range of study designs. Particularly, it was noted that scoping review is the prefered method for comprehensively summarizing and synthesizing diverse types of literature in emerging fields, with the aim of informing policy development (Arksey & O'Malley, 2005; Colquhoun et al., 2014). This methodology was chosen as most appropriate for this research as CC is an emerging field, where scoping review is required for mapping the field as means for informing policy development. Particularly, the method is useful for facilitating this study’s intention to create a bottom-up deductive thematic analysis of literature, relevant to informing the development and implementation of CC curriculum in K-12.

In line with this intention, inclusive search terms were used for retrieving literature and performing broad and detailed thematic analysis. Two types of publications were retrieved for this review.The first type was peer reviewed articles published primarily between 2010 to 2022. The second type of output consisted of grey literature. The grey literature included primarily policy documents and reports developed by international, regional and national bodies, as well as third sector organisations.

For retrieving peer-reviewed articles I used the following databases: Scopus, Eric, Google Scholar and A+Education. For retrieving grey literature I used primarily Overton, a database specifically developed for retrieving grey literature, particularly policy documents. The Internet sites of some governmental departments of education were accessed directly, using Google. Occasionally I aided the search with direct search in the OECD Library, and UNESCO Internet site. The search terms for both search types of peer reviewed articles and grey literature included: ("Education" AND "Climate Change"); ("Curriculum" AND "Climate Change"). Being aware of the fact that most literature addressing CC education is subsumed under sustainability education literature, I also applied the search term ("Curriculum" AND "Sustainability Education").

Following initial screening of the retrievals, 1631 peer reviewed publications and 229 grey literature, were found appropriate for further examining their abstracts. The following inclusion and exclusion criteria (see Table 3.1) were applied for the examination of the abstracts.

Table 3.1

Inclusion and exclusion criteria, based on abstract examination

Inclusion criteria	Exclusion criterion
• Period of 2010-2022 • Curricular examination in relation to: sustainability, citizenship, disaster risk reduction, or CC education; • CC education policy documents; • CC education epistemology; • CC education learning outcomes; • Content knowledge, attitudes and values related to CC education; • The role of behavior in CC and sustainability education; • Pedagogies and stategies for teaching CC; • CC teraching resources; • Assessment and standards for CC education; • Teaching CC and professional development; • Emotional aspects related to CC education; • Collaborations in CC education implementation.	• Language other then English or Hebrew • Documents focusing solely on sustainability education, with no mentioning of CC; • Sole focus on CC in tertiary education; • Sole focus on informal and extra curricular education.

Finally, 191 publications were analysed, including 92 peer-reviewed articles; 23 book chapters; and 76 grey literature.

In relation to peer-reviewed articles and book chapters, the authors of these publication were affiliated with 20 countries across five continents. Figure 3.1 represents the scope of publications by the authors' affiliated countries. Only the first four authors were counted per publication. Table 3.2 presents the number of authors per country. However, it is likely that the full scope of countries is more extensive. This is due to the fact that many publications involved multi-country collaborations, out of which only the first four authors were included in the count. For example, the study by Dawson et al. (2022) involved researchers from six countries. However, the first four authors included in the count were from three of the six countries, thus leaving out a country such as Malaysia.

Table 3.2 further reveals that while English speaking countries account for only 25% of the total number of countries presented in this research, the percentage of authors affiliated with English speaking countries is disproprtionately high, accounting for 68%. 188 of the total 277 authors, were affiliated with English speaking countries, with USA authors presenting triple the amount of publication compared to the next high ranking country, which is Australia (see Table 3.2). Similar to findings by Puttick and Talks (2021), who found in their scoping review that USA stands out in the amount of publications concerning CC resources, this study finds that this may be generelised to include CC education themes more broadly. This finding suggests that there may be further work related to CC education, conducted in non-English speaking countries that this review was unable to access, due to language barriers.

Concerning the grey literature, these were derived primarily through searching the Overton database, as well as from direct search in Google. Overall, the 76 documents retrieved reveal a wide scope of literature addressing CC education at various levels of political organizations, ranging across the international, regional and national levels. Figure 3.2 presents the scope of resources by organization type. The overall data selection process is presented in Figure 3.3 in a PRISMA chart.

In the process of analysis, each of the 191 publications was carefully read. Thematic analysis was applied for identifying the themes arising from the literature and critically analysing them. These themes are presented as section headings, and discussed in the the Results Chapter.

Figure 3.1

Authors of peer-reviewed articles and book chapters, by national affiliation and number of authors per country

Table 3.2

Authors' national affiliation in peer-reviewed articles and book chapters, by number of authors per country

Countries	Number of authors	Countries	Number of authors
USA	107	Denmark	5
Australia	29	Norway	5
United Kingdom	26	Netherlands	3
Finland	20	Singapore	3
Canada	19	New Zealand	2
Austria	16	Spain	2
Sweden	15	Chile	1
Germany	13	Iceland	1
Ireland	10	Israel	1
Switzerland	7	Mexico	1

Note. Total of 20 countries (*N*=20). Affiliations counted for the first four authors per manuscript.

Figure 3.2

Sources of grey literature by organization type, and number of publications per organization

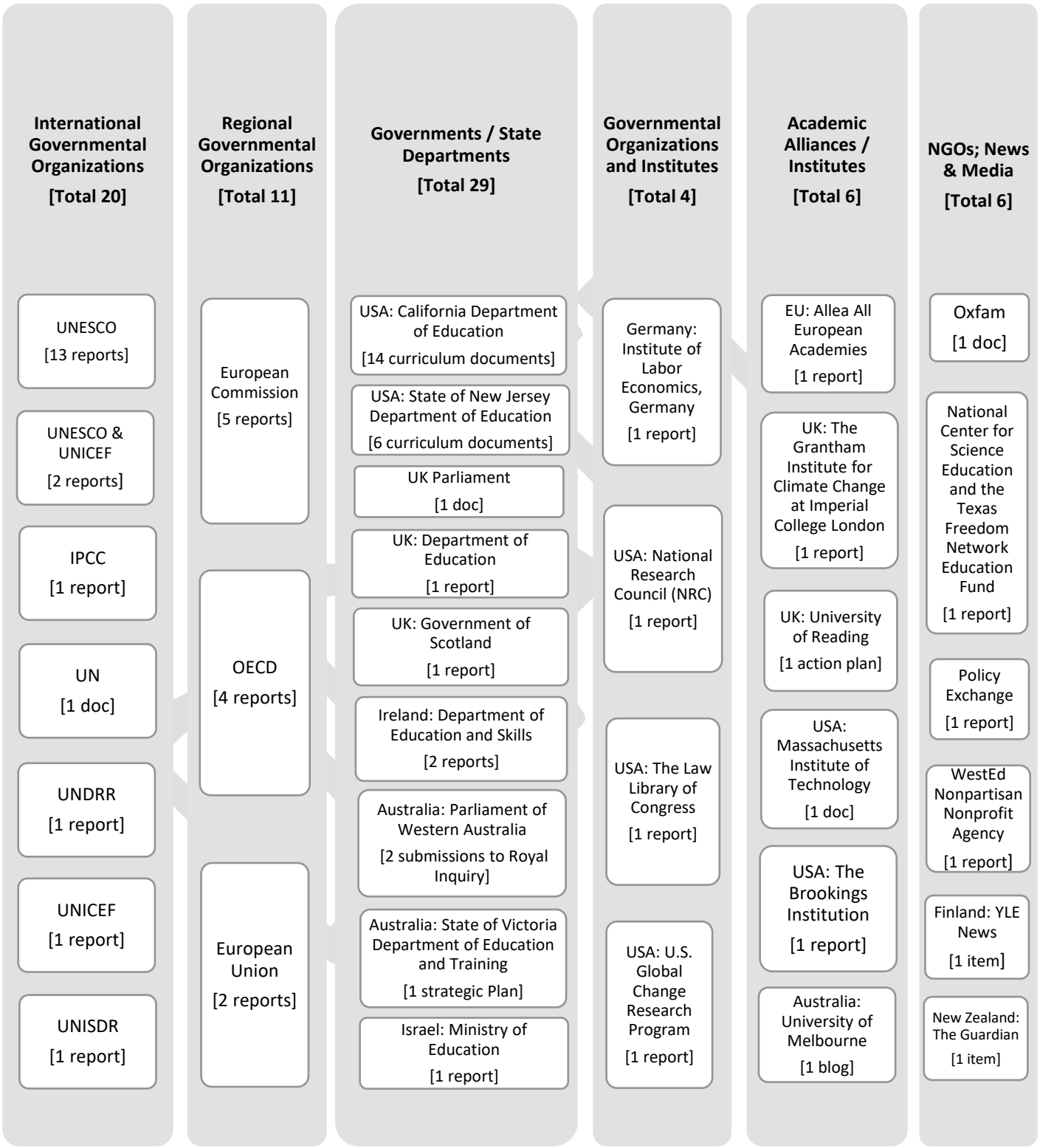
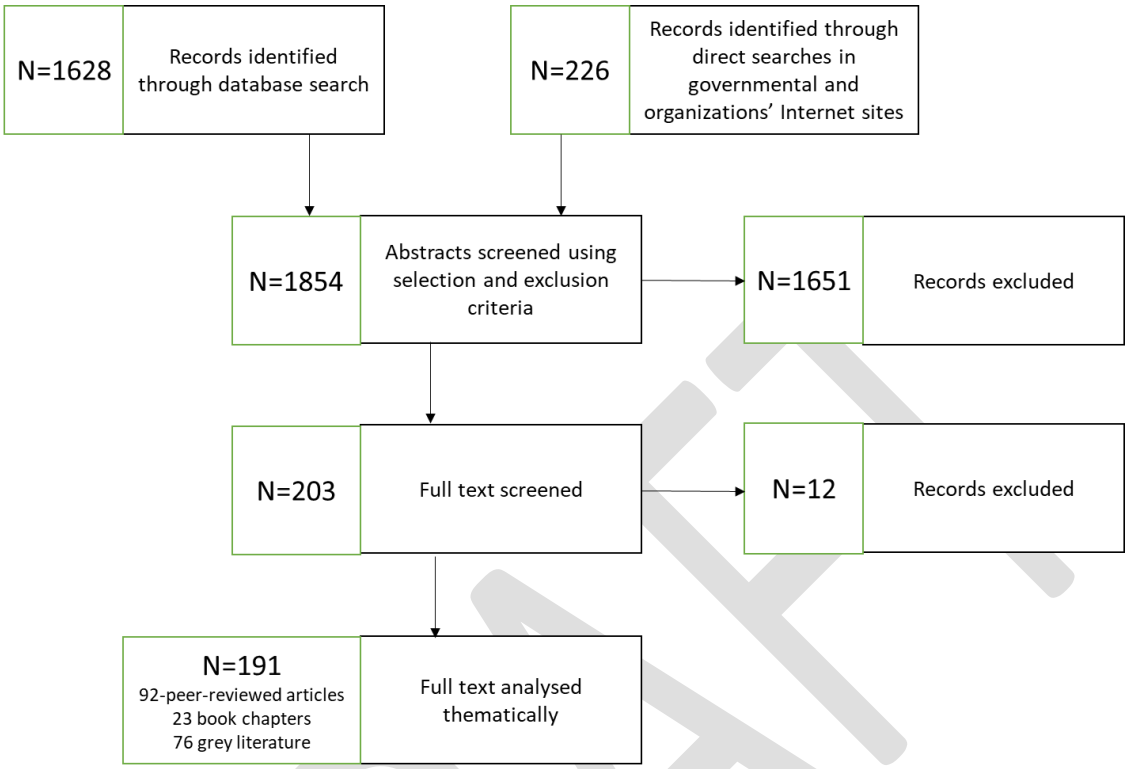


Figure 3.3

PRISMA chart presenting the resources selection process



CHAPTER 4. SCOPING REVIEW

4.1. Climate Change Epistemology: Contextualising Climate Change Education in Curriculum Theory and the Sustainability Education Agenda

This chapter aims to situate climate change (CC) curriculum development within a theoretical framework. It aims to provide the theoretical tools for considering the nature of CC as a body of knowledge; and provide the necessary theoretical underpinnings required for developing a sound CC curriculum. Unfortunately, there are no evidence-based best-practices in CC curricula available for 'picking up from the shelf'. To the best of knowledge, no one has yet developed and empirically tested CC curricula. In the absence of empirical evidence, this section aims to fill the gap by drawing upon a range of educational theories that are important for informing the development of a defensible and well-argued CC curriculum. These theoretical examinations are organised in five parts, as follows.

The first part begins by situating CC curriculum within Curriculum Theory, discussing trends and types of curricula; and considering the relationships between curriculum and learning.

The second part discusses CC epistemology. Here it poses the question: What is CC as a body of knowledge? This question is examined through various lenses, leading to the realisation that not only the ontological state of CC is in a dire state, but also that CC epistemology is un-defined and mis-defined in the educational literature, and particularly when addressed within the framework of sustainability education (SE). [1]

Accordingly, the third part examines the framing of CC education within the framework of Education for Sustainable Development (ESD), focusing on the following aspects: (i) demonstrating the conceptual problems within the sustainability education framework as reflected in a case study consisting of one publication; (ii) discussing the ESD conceptual problems through a chronological examination, tracking the formation of this field and the development of its agenda; and (iii) critiquing the suitability of the ESD agenda to act as a host for CC curriculum.

The fourth part of this chapter focuses on tensions related to the practical implementation of CC education. The first tension discussed relates to framing CC curriculum within the ESD agenda versus within the Intergovernmental Panel on Climate Change (IPCC)-based framework (The Intergovernmental Panel on Climate Change [IPCC], n.d.). Next discussed is the tension between the ESD agenda and the *content-based* curriculum.

The fifth part of this chapter is a form of endnote, where I present anecdotal comments regarding various unsubstantiated ESD concepts that potentially hinder CC curriculum development. The chapter concludes with summarising comments and a set of recommendations for theoretically grounded CC curriculum development.

4.1.1. Curriculum Theory: Situating Climate Change Curriculum Development in Context

When considering the development of CC curriculum, it seems worthwhile to begin by contextualising CC education within Curriculum Theory at large, and more particularly, in the context of current curriculum trends. Furthermore, the relationships between curriculum and learning also need addressing. This contextualisation may be helpful in understanding current push-and-pulls in

[1] In this report the term Sustainability Education (SE) is used interchangeably with the term Education for Sustainable Development (ESD). These are used as generalist terms for representing the myriad of names given to this field of education. Note: Throughout the remaining text, sustainability education is presented in the text as a generalist term un-capitalised.

regard to CC education conceptualisation, and in assisting policy makers in identifying and justifying their approach to CC curriculum development, within the current curricular landscape.

I begin by defining the concept of *curriculum*. This is followed by briefly pointing out selected historical milestones in curriculum thought. I then focus on presenting two currently contested approaches to curriculum development and explain the implications of each approach to CC curriculum development. Finally, I briefly address the issue of the relationships between curriculum and learning.

Curriculum is most commonly perceived as a dynamic system, which includes formal processes of policy making and curriculum development, and informal processes that emerge from the relationships, interpretations and enactment of the policy documents. These are referred to as planned (formal), taught, assessed, hidden (unintentionally taught), inner and null curriculum (i.e., what is omitted from it) (Ross, 2000; Schwab, 1973). Ross (2000) refers to school curriculum as the broad undertaking in which "anything that schools do that affects pupils' learning, whether through deliberate planning and organisation, unwitting encouragement, or hidden and unrealised assumptions, can all be properly seen as elements of the school's whole curriculum" (p. 9). However, curriculum may extend beyond school, and include any socially constructed activities, selected from culture (Ross, 2000).

Contrarily, Young (2014) proposed a narrower definition. In his view, curriculum is "basically specialized knowledge organized for transmission" (p. 198). Curriculum knowledge has two main attributes. First, that it is specialised "in relation to its disciplinary specialist sources" (e.g., geography, physics), and "in relation to different groups of learners" (e.g., their prior knowledge and year levels) (Young, 2014, p. 198-9). Not only is the curriculum perceived as specialised, but also the institutions in which it is delivered, such as schools and universities, and the teachers who deliver—they too hold specialised knowledge. The second attribute of curriculum knowledge is that it is different from everyday knowledge, in enabling students "to acquire knowledge that takes them beyond their experience, and they would be unlikely to acquire it if they did not go to school" (Young, 2014, p. 196).

Curriculum theory has evolved and changed over time and across nations. Some important milestones include John Dewey's (1902) pragmatist philosophy, with its progressive child-centred education, focusing on the process of learning, rather than on the contents of learning (Holmes & McLean, 2019). This curriculum philosophy was highly influential since the early 20th century in the USA and beyond. Additionally, the first half of the 20th century saw the rise of the positivist empiricist approach to curriculum theory, led by scholars such as Bobbitt (1918), Tyler (1950) and

Taba (1962). The role of curriculum was perceived as processing disciplinary knowledge into effective logical delivery, emphasising "effective sequencing (vertical organisation) and effective integration (horizontal organisation), and why" (Tyler, 1950, p. 59, as cited in Paraskeva, 2011, p. 67). The second half of the 20th century saw the introduction of Critical Curriculum Theory, led by scholars such as Pinar (1975), Apple (1971), and Giroux (1983). In its radical form, the theory tended to view the curriculum as merely a reflection of power relationships within the society and schools were perceived as oppressive institutions, inculcating amongst students the carefully selected knowledge of those in power (Paraskeva, 2011). The central question in Critical Theory became: Whose knowledge is being taught? rather than: What knowledge is being taught?

Baker (2015) notes that over the past 100 years, we increasingly see a trend toward curricular universalism, where a 'standard universalised' curriculum would often consist of: one or more national languages; mathematics, which is now perceived as a requirement for everyone; science; social science, which is often divided into sub-subjects; and often aesthetic education, such as arts, music or physical education (Ross, 2000).

Various typologies were developed for differentiating between curriculum types (Holmes & McLean, 2019). In the context of this discussion, two currently contested curriculum types are of particular relevancy. These are the *content-based* (or *content-driven*) curriculum and the *capacities-based (*may also be referred to as *objectives-driven)* curriculum (Ross, 2000).

The *content-based* curriculum is the most traditional form of curriculum, organised by disciplinary subjects. It is highly dynamic and evolving as both the subjects and their contents are not fixed, but rather transient, allowing new disciplines to emerge and justify themselves within the curriculum. In doing so the hierarchies of the subjects may change. Similarly, the subjects themselves evolve and reform over time (Ross, 2000). National curricula often allocate high status to foundational subjects, particularly those considered core subjects, and low status is relegated to the "cross curricular themes", which are "unbounded and non-classified" (Ross, 2000, p. 111). Thus, the lack of subject-boundaries is often a clear indication of low status in the disciplinary hierarchy. This can be exemplified in the Australian curriculum, in which the general theme of *sustainability* appears as a *cross curriculum priority* (Australian Curriculum, n.d.). The low status delegated for this subject can be demonstrated by the lack of achievement benchmarks and standardised tests for assessing outcomes. When considering CC education within the framework of the *content-based* curriculum, the curriculum developers working within this framework need to focus on scoping CC contents, identifying the structure and principles of organisation, typically by identifying key themes constituting the field, and key concepts within the themes. In this curriculum type, skills and practices are connected to contents, thus skills and practices acquisition are derived and connected

to knowledge acquisition, and do not appear as stand-alone attributes. Additionally, it is important to examine the status delegated to CC education, as reflected by setting boundaries, benchmarking and testing (Ross, 2000). These aspects are critically important since the status and scope of CC in the curriculum may potentially contribute to the extent and effectiveness of implementation.

The *capacities-based* curriculum is closely linked with what was described by Ross (2000) as the *objective-driven* curriculum. This curriculum is organised around specific capacities (the term *capacities* is defined elsewhere in this report) deemed as needed by the society or the economy. The capacities and objectives are specified in advance and the collection of subjects are justified by their ability to meet the objectives (Ross, 2000). The specification of the required capacities is used to justify the collection of subjects. Subject boundaries tend to be weaker since the emphasis is not on the academic worth of the subjects, but rather, on whether the subject is capable of delivering skills and capacities deemed worthy. The *capacities-based* curriculum is often associated with the neo-liberal individualistic worldview and the capitalist economy, emphasising the production of work-ready citizens through the development of personal capacities. When considering CC education within the framework of the *capacities-based* curriculum, curriculum developers need to assess the extent to which CC education is deemed socially and economically useful, and the capacities associated with CC education. According to this curricular framework, the CC subject matter has no value on its own. It only comes into play in relation to its ability to support capacities development. In this respect, questions related to the scope of contents, principles of organisation and form of inclusion in the curriculum, become secondary. This to the extent that the contents may be fragmented and dispersed across the curriculum, as is currently the case with most CC curricula worldwide (UNESCO, 2021a).

The growing emphasis on capacities has been described by Biesta and Priestley (2013a) as a change in learning outcomes from "what students should learn to what they should become". In other words, a shift from "a student being the subject who studies to being the outcome of education" (Biesta & Priestley, 2013, p. 7). For example, the 2004 Scottish Curriculum for Excellence (CfE) (Scottish Executive, 2004) puts forward the development of four capacities as constituting both the learning outcomes and the curriculum organisational framework. These are: "the successful learner, the confident individual, the responsible citizen and the effective contributor" (Biesta & Priestley, 2013a, p. 3). Biesta and Priestley (2013a) note that this trend has also been observed in other national curricula, including: the Australian Curriculum, referred to as *general capabilities* (Australian Curriculum, n.d.), the New Zealand Curriculum, referred to as *competencies* (New Zealand Ministry of Education), and the Northern Ireland curriculum, referred to as *cross-curricular skills* (Council for the Curriculum Examinations and Assessment).

Another line of critique, came from Young (2013) who bitterly critiqued the diminishing role of knowledge in curriculum theory, arguing that curriculum theory has lost its objective of theorising "what is taught and learnt at school" (p. 101). In his view, the focus needs to be shifted to the learner's "entitlement for knowledge" (p. 101), and to what constitutes "powerful knowledge*" (p. 101)* According to Young (2013) *powerful knowledge* is judged by its ability to advance students in their adult life. CC education provides a good exemplar of *powerful knowledge*, as the usefulness and importance of CC knowledge for adult life is becoming increasingly self-evident.

Roberts (2021) in his briefing paper to the UK Parliament provides an historical review of the school curriculum in England. The review presents a strong reflection of the curricular trends over time. According to this review, in the late 1980's with the rise of the neo-liberalism, the curriculum reform in England focused on increased school accountability. Later in the 1990's with the rise of the *objective-driven* curriculum, contents slimmed down paving the way to the cross-curricular themes, and the rise of *capacities-based* curriculum in the 2000's. The process of slimming down the curriculum contents continued into the 2010 reform, to be reversed in 2012 in response to increasing calls to put back 'proper contents' into the curriculum (Roberts, 2021). This view is increasingly gaining traction in the UK. For example, in a publication by Policy Exchange, a UK's leading think tank, Blake (2014) claims that "a coherent curriculum programme is rooted in the knowledge and discipline of the relevant academic subjects, where explicit reference is made to the research evidence in these areas" (p. 5); further stating that a knowledge-rich curriculum "can make a real difference in improving social mobility, reducing the influence on a young person's life outcomes of the socio-economic circumstances of their parents" (p. 16).

Currently, across the UK various curriculum reforms are calling to reinstate the centrality of knowledge in the curriculum. For example, The Scottish Commission on School Reform (2020) in their review of the current Scottish *capacities-based* curriculum, entitled Curriculum for Excellence (CfE), presents a clear call to bring back the knowledge, as follows:

> The Commission thus believes strongly in the importance of knowledge and considers that educational approaches which under-value knowledge are detrimental to the interests of learners. It believes that knowledge has been under-valued under CfE and that this is largely responsible for declining standards in Scottish education … The importance of knowledge and of the structures of knowledge accounts for the value that has traditionally been attached to a broad liberal education … CfE has been described as being based on constructivist philosophy, whereby pupils are expected to discover knowledge rather than acquire it. While there is an important role for discovery as a means of motivating pupils, constructivism is wholly inadequate as a principle of curriculum design. It is wasteful and ineffective to expect pupils to discover ideas that

> are well-established. Far more effective is to teach these ideas as part of interconnected bodies of coherent knowledge (Commission on School Reform, 2020, p. 11).

Indeed, Blake (2014) points out that curricula that exerts more control over students' subject choices is more effective in enhancing social equality. He demonstrates this by comparing the loosely subject-controlling Scottish Curriculum to the more tightly subject-controlling Irish Curriculum, as follows:

> Research comparing Scottish and Irish university admissions discovered that the more tightly controlled subject choices in the Irish school system meant that access to the best Irish universities was less likely to be a function of socio-economic status than in Scotland, where no formal limits on subject choice in the final years of school exist. Research on the impact of school curriculum content in England also concluded that much of the benefit in terms of future earnings, which accrues to English students who attended selective schools (either private or state-maintained), is a function of the curriculum they studied, not the selective nature of their schools (p. 16).

While these critiques are growing in scope, worldwide the capacities-based curriculum appears to be widely spread. Importantly, however, it seems that regardless of the current curriculum trends to move away from disciplines, these continue to be persistent across most curricula. As noted by Young and Muller (2010): "it has become fashionable to proclaim the end of disciplinarity ... but disciplines seem almost obstinately to linger on" (p. 20). This seems to be the case in every curriculum examined for the purpose of this report.

4.1.1.1 Curriculum and Learning

For a curriculum to be effective in achieving its teaching goals, the structure of the curriculum must be intimately connected to the structure of knowledge and its acquisition. In other words, the ways by which our brains learn need to be reflected in the ways by which the curriculum is designed to inform teaching. There is consensus among researchers in cognitive psychology that learning "involves a change in long-term memory along with mechanisms for retrieving ideas from long-term memory. If nothing has altered in long-term memory, nothing has been learned" (Commission on School Reform, 2020, p. 10). This means that knowledge acquisition forms a fundamental aspect of any educational process, and therefore curriculum development must address the epistemological question of the nature of the knowledge being taught.

Most educators agree that the role of school education is not only to provide students with knowledge, but also to support their overall growth as capable citizens who can enjoy an overall sense of well-being. Still, the role of knowledge in supporting both cognitive and emotional development, as well as range of skills acquisition, is fundamental to the process, and thus must be

addressed properly in the curriculum. Research in the fields of epistemic cognition, epistemic emotions, and cognitive psychology (e.g., Chinn & Buckland, 2011; Muis et al., 2021; Sweller et al., 2019) provide ample information that may be useful in informing CC curriculum development. While expanding on this body of research is beyond the scope of this report, one thing that stands out clearly across these fields of research is that for knowledge to be processed effectively it needs to be systematically structured and organised. In other words, there is "overwhelming research on learning showing the importance of organizational structures for helping students progress to become experts" (State Board of Education Policy on the Teaching of Natural Sciences, 2018, n.d.). Thus far no form of knowledge organisation has been found to be more effective than disciplines in offering structured and organised knowledge (Blake, 2014).

In recent years, various ideas of learning have become associated with CC education, some of which may form barriers for effective curriculum development. These ideas include notions such as differentiating between the learning domains: cognitive learning, socio-emotional learning and behavioural learning; or ideas such as future thinking and holistic learning (e.g., see UNESCO, 2017). These ideas hold no currency in theories of learning and the current understanding of brain functions. There are no three separate domains of learning that may be taught separately, acquired separately, and assessed as separate distinguishable domains. This is expanded upon below, in the section entitled Footnotes. Similarly, in relation to future thinking, it is well established by now that our brains are essentially predicting machines, and that the human brain is only capable of making predictions into the future based on past learnt experiences (Barret, 2020). Bruno Latour (2021) described this vividly, as follows:

> "Organisms have no eyes to see things ahead; they have eyes only in the back, after the fact. Blindness to the future is a life condition. But organisms can be slow or fast in registering the consequences of what they have done" (p. 15).

When this brain function is considered, what does future thinking actually mean? Finally, the notion of holistic learning is another rather empty term. In essence, learning is never holistic and always holistic. It is never holistic because our brains have no capacity to take bundles of information and simplistically load them onto the long term memory. Information needs to be carefully selected, broken down and processed before it can move from the working memory to the long-term memory (Sweller et al., 2019). At the same time, it is always holistic due to the interconnectivity of past and present experiences, emotions, thoughts bodily input and environmental input in the process of learning. From a curriculum application perspective, the above three ideas (and others circulating) are practically useless, as they are not supported by any sound evidence.

Perhaps a more useful way to think about the ways in which the different cognitive–emotional–social aspects work together to create meaningful learning may be assisted by the Cognitive Load Theory (Sweller et al., 2019). This theory suggests that there are two types of knowledge, *biologically primary knowledge* and *biologically secondary knowledge*. Biologically primary knowledge consists of generic cognitive skills which humans evolved to acquire naturally without instruction, in the same way that young children learn to speak their native language. This knowledge is concerned with how we learn and solve problems. Due to its innate nature, this knowledge is very difficult to teach. A good example of its stubbornness against teaching, may be exemplified in recent years' attempts to teach argumentation from evidence, in the context of applying socioscientific issues in science classes (Evagorou et al., 2011; Sadler, 2004). This is because argumentation is a generic skill. Contrarily, biologically secondary knowledge is "knowledge we need because our culture has determined that it is important. … All secondary knowledge tends to require conscious effort on the part of the learner and explicit instruction on the part of an instructor" (Sweller et al., 2019, p. 271). Skills associated with biologically primary knowledge are generic and can be acquired independent of disciplinary knowledge. Contrarily, biologically secondary knowledge skills are heavily discipline-specific (Sweller, 2015, 2016). Importantly, learning always involves a combination of primary and secondary knowledge. However, what is critical to note is that while the secondary knowledge is teachable, the primary knowledge (involved in the same process at the same time) is mostly not teachable (Sweller et al., 2019).

Furthermore, a range of studies suggest that epistemic cognition, epistemic emotions, and critical thinking are all engulfed in complex relationships during learning (Muis et al., 2021); and in practical terms they are inseparable, neither from the aspect of teaching strategies, nor from the aspect of assessing learning outcomes. Similarly, any learning activity involves a range of executive functions concerning monitoring, organising, planning, and strategising, as well as emotional and impulse control (Kuhn & Franklin, 2008).

Considered together, the various most up-to-date research into learning and cognition have a range of practical implications to CC curriculum development. First and foremost, it suggests that CC curriculum developers focus on developing a curriculum based on disciplinary-specific knowledge and skills, rather than on generic skills, which teachers have minimal control over their acquisition. In this context the Scottish Commission on School Reform (2020) reminds us that "skills do not exist in a vacuum but depend upon knowledge. This applies even to so-called thinking skills. It is not possible to think without thinking about something" (Commission on School Reform, 2020, p. 10).

Secondly, by developing high quality CC curriculum that is both conceptually challenging and intriguing, the process of teaching and learning will inevitably involve application of a range other

generic skills, emotions, bodily and behavioural responses. However, while curriculum has little control over these secondary affective and physiological aspects, it has much to say on creating the circumstances and opportunities that allow them to arise effectively.

On the background of the above curricular push-and-pulls, the introduction of ESD with its claimed ownership over CC education (UNESCO, 2021a), poses a particular challenge to CC curriculum development. This is because ESD introduces a whole new set of assumptions discussed below, which further challenge the traditional disciplinary-content-based curriculum and the inclusion of CC in the curriculum through evidence-based practices. In what follows I present an analysis of CC epistemology, leading to in-depth examination of CC education conceptualisation within the framework of ESD. This is followed by a set of recommendations.

4.1.2 Climate Change Education Epistemology

4.1.2.1. What is Climate Change as a Body of Knowledge?

Climate Change—what is it? Is it a discipline? Is it a field of knowledge within a discipline? Perhaps it is a concept, an idea, a theme, a capacity, an event, a crisis, a process or an aspiration. This fundamental epistemological question seems critically under-researched. Review of the research reveals multiplicity of terms expressing multiplicity of conceptualisations, mostly used uncritically and seamlessly. Nevertheless, answering the epistemological question of: What is CC knowledge? is highly important in guiding curriculum development. If we don't know the nature of the knowledge, scope, sources and structure of the knowledge that we are teaching, how would we know the appropriate ways for including it in the curriculum, determining learning outcomes and assessment measures?

The majority of publications reviewed seem to agree on one thing. That CC is multi-disciplinary and/or inter-disciplinary (e.g., Mulvik et al., 2022; UNESCO, 2021a,b). While these terms convey the idea that the knowledge is derived from multiple sources, they are not helpful in addressing the epistemological question of what this knowledge is. In my view, describing knowledge of any sort, be it a concept, an idea or a discipline as multi-inter-disciplinary (referred to from here after as multidisciplinary) is epistemologically lacking. This is because most knowledge created by humans may be characterised as multidisciplinary. Take, for example, a concept such as 'photosynthesis'. At its narrowest, it involves physics (light energy), chemistry (light energy transformed into chemical energy), and biology (the transformation takes place in proteins). At its broader interpretation, photosynthesis is a critical aspect of ecology with its contribution to biomass and bioproductivity. It is also involved in biogeochemical cycles, impacting the climate; it impacts atmospheric patterns as

expressed in the seasonal variations of carbon dioxide in the Keeling Curve (Keeling et al., 1976). Greenery forms an essential aspect of urban landscaping, architectural biodesign, and more. The same can be said for all disciplines. They are all multidisciplinary in essence. Biology evolved from Zoology and Botany (Goodson, 1987). Ecology evolved from the Biology, Chemistry, Physics and Earth Sciences (Odum, 1977). Geography involved Sociology, Climatology, Urban Planning, Geology, and other sources of disciplinary knowledge. Psychology involves Science and Sociology, and so on it goes. Thus, referring to multi-disciplinarity as the sole descriptor of a body of knowledge is not helpful for advancing curriculum development. It may even act as an obstruction, as it gives a false idea that we have characterised the field, where in effect, we have not. Furthermore, characterising CC as multidisciplinary is insufficient because it still leaves us with the question of: What are the disciplines that make up the multi-disciplinary knowledge? Obviously, if there are no disciplines, there is no multi-disciplinarity. In Gardner's words: "If no single discipline is being applied, then clearly interdisciplinary thinking cannot be at work" (Gardner, 2007, p. 55).

In previous work I have made a case as to why CC should be conceptualised as a discipline. "Disciplines are characterised by the ways in which the knowledge is produced, applied, valued and evaluated, as well as rules and concepts related to governing epistemological principles (Duschl & Grandy, 2013; Young, 2013, 2014)" (Eilam, 2022, p. 9). The article makes an argument suggesting that CC demonstrates a wide range of characteristics typical to disciplines. To name a few, these include: "specialised knowledge in both structure and purpose (Young, 2013)" (p. 9); "Concepts within a discipline are linked to each other and to their underpinning theories (Ross, 2000; Young, 2013)" (p.9); and, disciplines form "communities of specialist discourse, supporting the development of professional identities (Harland et al., 2006)" (p. 9). Furthermore, in referring to the seminal work by Joseph Schwab (1967) in the field of Curriculum Theory, CC demonstrates all three structural aspects of disciplines, including: (i) internal organisation in relation to the contents and their relationships; (ii) a substantive structure, relating to the essential concepts and principles that guide the research"; and (iii) a syntactic structure, relating to the canon of evidence, and ways of establishing proof. Disciplinary knowledge is never fixed and is always open to changes. Young (2013) adds that the disciplinary boundaries are "always fallible and open to challenge" (Young, 2013, p. 107), as is the case with CC, with its ever-expanding boundaries and contents, since the early studies by Guy Callendar, who in 1938 showed that the steady rise in temperature over a century is associated with the rise in carbon dioxide (Le Treut et al., 2007, in Eilam, 2022).

Most subjects in the curriculum are derived from disciplines. However, this involves a range of considerations when selecting from the discipline contents, skills and principles for school subject delivery. Schwab (1973) suggested that the process of translating a discipline into a subject should

take into account the subject matter, the learners, the school community and social environment (referred to as 'milieu'), the teachers and the curriculum-making itself. Additionally, the process of translating disciplinary knowledge produced by experts into subjects involves a range of organisational processes such as inclusion in the curriculum, allocation of the subject to teachers who are disciplinary specialists, timetabling, examination, and training courses for teachers (Ross, 2000).

When considering the delivery of CC education within the school system, one cannot but wonder about the epistemological uncertainty and vagueness surrounding CC. For most other curriculum contents deemed important and ranked highly in the curriculum hierarchy, such as Mathematics, Science and Literacy, there are allocated subjects, teaching hours and specialised teachers. This is particularly the case in secondary schools, where the disciplinary contents become more complex.

So why is it that only CC has gained the unfortunate fate of being fragmented, torn apart and dispersed across the curriculum under the banner of multidisciplinarity? Why is it that even when teaching hours do become allocated to CC, these hours are scattered across the curriculum rather than allocated within a dedicated space? This is clearly not the case for most other multidisciplinary subjects, such as Geography, Civics, History and more. Even more puzzling, is the lack of theoretical rational or empirical evidence for supporting this unusual approach to CC curriculum development.

When it comes to conceptualising CC, epistemological vagueness and inconsistencies permeate most of the reviewed literature. Here I present some examples of CC education diverse conceptualisations, as they commonly appear in educational literature.

Climate change forms part of science literacy. According to the U.S. Global Change Research Program (2009), CC is purely a field within science. This is explicated as follows:

> People who are climate science literate know that climate science can inform our decisions that improve quality of life. They have a basic understanding of the climate system, including the natural and human-caused factors that affect it. Climate science literate individuals understand how climate observations and records as well as computer modeling contribute to scientific knowledge about climate. They are aware of the fundamental relationship between climate and human life and the many ways in which climate has always played a role in human health. They have the ability to assess the validity of scientific arguments about climate and to use that information to support their decisions" (U.S. Global Change Research Program, 2009, p. 4)

While the report views CC as a field of science it acknowledges that to be fully climate literate there is a need for input from the social sciences related to economic and social considerations.

CC as a geographical process. This conceptualisation appeared in Waldron et al. (2019) and it was also found among Geography teachers in Israel (Naugauker, 2022).

Climate change as an environmental issue. Cross-national comparisons of CC curricula reveal that various curricula tend to frame CC as a sub-theme, or an issue of the environment, included in Environmental Literacy (Blum et al., 2013; Dawson et al., 2022). Similarly, Ángel & Cartea (2020) refer to CC education as an area of EE, defining it as follows: "Climate Change Education (CCE) is a specific area of Environmental Education aiming at designing and developing educational responses based on informed decisions intended to be effective in the context of the climate crisis" (p. 109).

CC is a theme of Education for Environmental Sustainability. This view underlies Malvik et al.'s (2022) report commissioned by the European Union, discussed below.

CC is an energy systems issue. Jorgenson et al. (2019) make a case as to why CC needs to be framed as an energy issue, suggesting that this framework needs to be used for promoting environmental action.

CC are capacities within Education for Sustainable Development. In UNESCO (2015) CC education is conceptualised as capacities development within ESD, primarily covering aspects of adaptation and mitigation, stated as follows: "Building climate change awareness and building capacities for adaptation and mitigation are critical dimensions of ESD" (UNESCO, 2015, p. 2).

CC is a topic or theme of Education for Sustainable Development. The various UNESCO documents frequently address CC as a topic or a theme of ESD as exemplified in the following statement: "UNESCO promotes climate change education through ESD … Climate change is a critical thematic focus across all five Priority Action Areas of the Global Action Programme (GAP) on ESD" (UNESCO, 2015, p. 2).

Some authors, while conceptualising CC as a topic of EE or ESD, emphasise that as a topic it needs to appear in its own right within the broader scope of sustainability. For example, Pearson (2021) states that while CC is "enmeshed with environmental education and education for sustainability, it is a field of inquiry in its own right" (p. 33). I note here the term enmeshed as an epistemological descriptor of knowledge.

ESD as a means to achieve the SDGs, including SDG13 Climate Action. The UNESCO (2020) roadmap calls for including education in every SDG and emphasises ESD in SDG13 as follows: "ESD should be prominently placed in all policies that address climate change (SDG13)" (UNESCO, 2020, p. 26). This conceptualisation flips the roles. Where previously CC education was included in ESD, now ESD

served the Climate Action goal. Additionally, while previously the education system was expected to serve the ESD agenda, here the ESD agenda is expected to serve the SDG's agenda (UNESCO, 2017).

CC may best be addressed in Civic Education. According to Kessler (2021) Civic Education has better tools than other fields to increase civic participation on CC issues among students.

In summary, when it comes to conceptualising CC and CC education, it seems that every author takes a free hand to characterise CC as they please, overall creating epistemological vagueness, inconsistency and terminological chaos. These form major obstacles for CC curriculum development. The following section elaborates on the terminological chaos.

4.1.2.2. Terminology Associated with Climate Change

Conceptually, CC has been associated with multiple terms, including: Carbon Literacy (Government UK Department of Education, 2022); Citizenship Education (UNESCO, 2021b); Civic Education (Kessler, 2021); Climate Change Education (CCE) (Ángel & Cartea, 2020); Climate Crisis (Ángel & Cartea, 2020); Climate Education (CE) (Bieler et al., 2017); Climate Literacy (U.S. Global Change Research Program, 2009); Climate Science Literacy (Busch & Román, 2017); Development Education (Blum et al., 2013); Disaster Risk Reduction Education (DRRE) (UNESCO & UNICEF, 2014); Ecological Education (Mulvik et al., 2022); Education for Environmental Sustainability (EES) (Mulvik et al., 2022); Learning for Environmental Sustainability (LES) (European Commission, 2022); Education for Sustainability (EfS) (Mulvik et al., 2022); Education for Sustainable Development (ESD) (UNESCO, 2021 a, b); Environmental Education (EE) (Mulvik et al., 2022); Environmental Sustainability Education (or Environmental and Sustainability Education) (ESE) (Aikens & McKenzie, 2021); Global Citizenship Education (GCE) (UNESCO, 2020); Global Education (European Commission, 2022); Peace Education (European Commission, 2022); and Sustainability Education (SE) (European Commission, 2022). These terms were selected from a range of literature discussed in this report, all addressing CC education.

I am not familiar with any other curriculum subject or even topic, where there is no agreed term signifying the body of knowledge under consideration. While some would argue that the various terms are reflective of debates within the field, the multiplicity of terms actually signifies the non-existence of a field. This is because debates are commonly conducted within disciplines, typically characterising disciplines that have reached a level of maturity (Harland et al., 2006). However, when debates lead to the establishment of so-called new fields with new designated titles, this suggests a neologistic exercise of naming rather than any meaningful epistemological debate related to the nature of knowledge at hand. This naming practice differs significantly from the ways knowledge is commonly treated in disciplines. Here not only that the disciplines themselves have agreed names,

but also the terminology within the disciplines is unified. For example, Analytical Chemistry, or Genetics; as well as the more highly-specialised fields of Population Genetics and Molecular Genetics. Overall, the lack of terminological consistency is an indication of the lack of an epistemological clarity.

In addition to the terminological and conceptual inconsistencies and ambiguities, some of the studies expose what seems to be an empty debate as to which term is capable of including more of the world's problems, or emphasise problems insufficiently addressed under other terms. For example, Mulvik at al. (2022) claim that "the majority of Member States have moved away from the term Environmental Education towards Education for Sustainable Development and have thus widened their thematic focus to also factor in social and economic issues" (p. 113). This form of argument is typical in this debate, where each term pushes aside the former term claiming that it is not inclusive enough, while no real conversation is taking place regarding what this knowledge actually means and what needs to be done with all these assembled world issues, in educational terms.

The lack of terminological consistency is reflected in educational policy documents. Examination of national educational policies revealed that 72% of policy documents continue to use the term EE, whereas ESD appears only in 26% of national policy documents (UNESCO, 2019). In the debate between EE and ESD, Aikens and McKenzie (2021) report that in countries with strong EE tradition, such as the USA, UK and Canada, the term EE is continued to be used as the preferred descriptor. However, in Canada they found different terms used in different provinces, including EE, ESD, and Indigenous Education.

When it comes to CC itself, here too there is no consistency. Some national policy documents and scholarly research use the terms Climate Education or Climate Literacy (Bieler at el., 2017; U.S. Global change Research Program, 2009). This is surprising as the study of climate is carried out within the framework of the discipline of Climatology. Using the term Climate Education seems a reductionist approach, as the relationship between CC and Climatology are somewhat analogical to the relationships between Ecology and Biology. Similarly, using the term Biology when addressing the scope of concepts relevant to Ecology, would appear reductionist. This is because the discipline of Ecology includes biological knowledge, but also knowledge derived from other disciplines. Similarly, CC as a discipline includes climatological concepts. However, it also includes concepts beyond climatology.

Blum et al. (2013) claimed that the diversity of conceptualisations and terms used by different organisations at different locations fuelled across the UK and other countries tensions and debates

concerning the very nature of education and its goals, including the fierce debate between *content-based* curriculum and *capacity-based* curriculum. In what follows I elaborate on the problems arising for CC education conceptualisation, when CC education is addressed within the framework of ESD.

4.1.3. Conceptualising Climate Change Education in the Context of Sustainability Education

As mentioned above CC is commonly conceptualised as a topic of sustainability education (Waldron et al., 2019). In this section I aim to make the case that the subsuming of CC under sustainability education causes epistemological chaos that in turn limits effective CC curriculum development. To explain and justify this statement, two approaches are applied. The first utilises a case study in which a text is selected from a publication by a reputable organisation. The selected text is analysed to identify the conceptualisation of CC in the context of sustainability education, exemplifying the epistemological chaos. In the second line of argument, I critically analyse UNESCO's conceptualisation of ESD, through tracking the development of the ESD agenda along a chronological timeline. Finally, the limitations of ESD as a framework for developing CC curriculum are discussed.

4.1.3.1. A Case Study Examination

Here I draw upon one publication, published by a reputable organisation, the European Commission, using it as a case study for demonstrating the conceptual problems derived from the sustainability education approach in general, and the subsuming of CC under that approach. For the purpose of the case study analysis, the following publication was selected:

Mulvik, I., Pribuišis, K., Siarova, H., Vežikauskaitė, J., Sabaliauskas, E., Tasiopoulou, E., Gras-Velazquez, A., Bajorinaitė, M., Billon, N., Fronza, V., Disterheft, A., & Finlayson, A. (2022). Education for environmental sustainability: policies and approaches in European Union Member States: Final report. European Commission, Directorate-General for Education, Youth, Sport and Culture file:///C:/Users/e5101581/Downloads/Educationforenvironmentalsustainability.pdf

Malvik et al. (2022) examined policy approaches to Education for Environmental Sustainability (EES) within the European Union. Their report was commissioned by the European Commission. Here I focus on one selected paragraph from the report. In their report, CC is addressed within the context of EES. However, the report presents epistemological ambiguity in relation to both CC and EES. According to the report, EES consists of various themes, including: CC, sustainable production and consumption, biodiversity, habitats-and-homes, forests, renewable-energy, water, air, soil quality, disaster risk reduction, ecosystems, sustainable cities and lifestyles and more. According to this conceptualisation, CC is peculiarly placed as a theme next to other themes such as renewable-energy

and habitats-and-homes. However, a sentence later the 'themes' are referred to as 'topics', as follows: "While these are some of the prominent topics with education for environmental sustainability, the concept goes beyond the specific thematic areas with which it may be identified" (Mulvik et al., 2022, p. 8). According to this sentence, themes and topics are essentially the same. Both seem to constitute the *concepts* of EES. Thus, EES is a *concept* made of *topics/themes* and other things, which are referred to as "go beyond" (ibid, 2022, p. 8).

The epistemological confusion continues in the next few sentences, stating that "research suggests that sustainability should not be viewed as a topical subject exclusively, but an inter-disciplinary issue. As such, it should be less defined by the themes it addresses than by the styles of thinking, knowledge, values and attitudes it embraces" (ibid, 2022, p. 8). Here the reader is exposed to a new catalogue of epistemological signifiers. First it states that sustainability is not a topical subject (whatever this means), but it is actually an issue, characterised as inter-disciplinary. This suggests that according to the authors, epistemologically a topic cannot be inter-disciplinary, yet an issue can be inter-disciplinary. The text then continues to claim that as an issue, this knowledge is not characterised by themes, but rather by "thinking styles, knowledge, values and attitudes" (p. 8). From this we can conclude that themes/topics are not made up of knowledge. This is because the text clearly states that sustainability is not made up of themes, but rather made up of knowledge and the other mentioned items (it is not clear what thinking styles means). The confusion continues into the next sentence stating that "this study, therefore, recognises that all topics and sustainability goals are important and interconnected. It emphasises that they should be approached holistically, not simply as individual environmental concepts and sustainability goals, but by regarding sustainable development as an overarching and holistic concept" (ibid, 2022, p. 8). According to this text, EES is once again a concept made up of topics. However, this time it is a holistic concept (it is not clear what a holistic concept is). Furthermore, the text suggests that EES is made up of topics and sustainability goals. In the second sentence of the quote, topics and sustainability goals are equated with environmental concepts and sustainability goals. If we now go back to the first list of themes making up EES, one may conclude by deduction that CC is an environmental concept.

The above analysis of a section of the Mulvik et al. (2022) report clearly demonstrates an epistemological chaos when it comes to conceptualising CC in the content of EES, and the same applies for contextualising CC in the context of ESD, as EES is just a different term used to describe ESD. The reason I expanded on this particular text is to demonstrate the inconceivable conceptual absurdities prevalent throughout the literature, even in reputable publications, such as this one, which was published by the European Commission.

4.1.3.2. Epistemological Ambiguity: Chronological Examination of ESD Agenda Evolvement

The peculiar epistemological ambiguity of CC, to some extent may be explained by CC's close association with various educational initiatives promoted by international organisations such as UNESCO. These include the Decade of Education for sustainable Development (UNESCO, 2005), The Global Action Programme (GAP) on Education for Sustainable Development (UNESCO, 2014) and the Sustainable Development Goals (UN, 2015).

Common to these initiatives and others specified below is their epistemological ambiguity, inconsistencies and even contradictions, in relation to what ESD and CC knowledge are. This lack forms a major obstruction to curriculum development, as curriculum in its very essence deals with knowledge. Knowledge that is not structured, not organised and not specified poses critical challenges for assimilation in school systems. This is because the backbone of school education is the curriculum, and for knowledge to fit into curriculum structure it needs to meet some basic organisational criteria. This is not the case in ESD and CC conceptualisation among some international organisations. In what follows I focus particularly on the role of UNESCO in muddling CC knowledge and obstructing its effective inclusion in the curriculum.

Since the 1970's the United Nations with its various organisations became involved in promoting EE. The framework for what is known today as ESD was laid out as early as in 1977 in the first Intergovernmental Conference on Environmental Education in Tbilisi, Georgia. Criterion 3 of the Declaration states:

> A basic aim of environmental education is to succeed in making individuals and communities understand the complex nature of the natural and the built environments resulting from the interaction of their biological, physical, social, economic, and cultural aspects, and acquire the knowledge, values, attitudes, and practical skills to participate in a responsible and effective way in anticipating and solving environmental problems, and in the management of the quality of the environment (UN, 1977).

The goals of EE were presented as follows:

1. to foster clear awareness of, and concern about, *economic, social, political*, and *ecological i*nterdependence in urban and rural areas;
2. to provide every person with opportunities to acquire the *knowledge, values, attitudes, commitment*, and *skills* needed to protect and improve the environment;
3. to create *new patterns of behavior* of individuals, groups, and society as a whole towards the environment (UN, 1977)

The Declaration continued to specify guidelines such as developing critical thinking and problem-solving skills, utilising diverse learning environments and other pedagogical aspects of implementation. In essence, the conceptual foundations laid out by the Tbilisi Declaration have

remained the same to this day. What has changed is the terminology used, and the areas of emphasis. Additionally, the expansion of the understanding regarding the world's major challenges has led to the broadening of the scope to include more urgent concerns, such as CC.

In 2002, in the World Summit on Sustainable Development, in Johannesburg, South Africa, the term Environmental Education was officially replaced by Education for Sustainable Development, and the UN General Assembly Resolution 57/254 designated 2005–2014 to be the United Nations Decade of Education for Sustainable Development (DESD) and UNESCO as the lead agency (UNESCO, 2005). Since then, UNESCO has been leading the ESD agenda (UNESCO, 2020). The DESD strategy presented 15 strategic perspectives that formed the scope of contents addressed by ESD (see the list of strategies in Table 4.1.1).

Examination of the 15 perspectives reveals that most of them do not represent any organised body of knowledge. Epistemologically, they may be best characterised as a set of world challenges relevant to the time of their conceptualisation in the early 2000's. Consequently, UNESCO's conceptualisation of the DESD was described by Kwauk (2020) "as turning a robust field of environmental education into a 21st century simulacrum of education for sustainable development (ESD) detached from reality—or more precisely, untethered to the planet" (p. 7).

Later in 2012 at the Rio+20 conference on Sustainable Development, UNESCO introduced an addition to the DESD perspectives, focusing attention on the role of education in addressing sustainable consumption and production, presented as follows: "Sustainable consumption and production: Sustainable Lifestyles and Education Programme of the 10-Year Framework of Programmes on Sustainable Consumption and Production 2012–2021" (UNESCO, 2020, p. 6).

A year later, in 2014, UNESCO launched a Global Action Programme (GAP) on ESD (2015–2019), aiming to follow up on the DESD that was coming to closure. In the UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development (UNESCO, 2014), the dimensions of ESD include: Learning content, pedagogy and learning environments, learning outcomes and societal transformation. From an epistemological perspective, ESD appears in the roadmap primarily as an agenda aiming to utilise education for the purpose of societal transformation, as an end goal. Priority Action Area 4 describes the means as "Empowering and mobilizing youth" (UNESCO, 2014, p. 15). This reorientation agenda is farther strengthened in the 2020 UNESCO Roadmap (UNESCO, 2020), where the document clearly states that "education needs to transform itself" (p. 9); and that the aim is "to review the purposes and values that underpin education and reorient all levels of education and learning to contribute to sustainable development" (p. 12). The document further calls for surveillancing education systems and to

"ensure that education institutions are monitored and assessed for progress on how well they develop learners' capacities as change agents" (UNESCO, 2020, p. 26). Some educators may be alarmed by this apparent attempt to hijack the education systems for achieving a prescribed agenda, as most educators would think of schools as places where children are supported to grow to their full potential, whatever that may be, and not as training facilities for prescribed purposes. Or in Biesta's words "… what they [the students] will do when it matters, that is, when they encounter something in their lives that addresses them and calls for them … is something we can never know in advance, which also means that it is fundamentally beyond our control" (Biesta, 2022, p. vii). Furthermore, Biesta (2022) suggests that "… instead of asking what the schools should "do" for society—which seems to have become the most prominent way in which the task of the school is nowadays being conceived—I ask what society should "do" for the school so that the school can be a school" (p. 9).

The Roadmap further elaborates on its agenda as follows:

> ESD is transformative education in that it aims at reorienting societies towards sustainable development. This, ultimately, requires a reorientation of education systems and structures as well as a reframing of teaching and learning. ESD concerns the core of teaching and learning and cannot be considered an add-on to existing educational practices (UNESCO, 2020, p. 33).

This quote further suggests that epistemologically ESD is an agenda, not an organised body of knowledge. Schools and education systems are called upon to re-route their purposes and educational operation modes to serve this agenda. As such, it is questionable as to whether it is morally right to allow any agenda to govern the curriculum.

In 2015 with the adoption of the 17 Sustainable Development Goals (SDGs) and Agenda 2030 for global transformation, ESD conceptualisation shifted once again. This time it was viewed to be included in Target 4.7 of SDG4 Quality Education; Target 12.8 of SDG 12 Responsible Consumption and Production, and Target 13.3 of SDG 13 Climate Action. In 2017 UN General Assembly Resolution 72/222 broadens ESD's role once again to be 'an integral element of the SDG on quality education and a key enabler of all other sustainable development goals' (UN, 2018, p. 3), thus forming a new list of ESD issues. Table 4.1.1 presents the shift in ESD issues when transitioning from the DESD strategic framework to the SDG framework. Examination of the two lists of contents reveals that except for Gender Equality, all the other titles have changed. Even Climate Change is now changed to Climate Action. Taken together, the analysis reveals that epistemologically, ESD may best be characterised as an agenda for addressing the world's main challenges.

This entails a perpetual conceptual inconsistency. This is because problems and challenges are always transient. Like the problems and challenges that individuals encounter throughout life, the world's problems are also continuously changing over time. It follows that attempts to organise curricula around problems rather than around structured knowledge, will meet insurmountable challenges in relation to all aspects of curriculum design, as elaborated further below.

Table 4.1.1

ESD scope of contents in the Decade of Education for Sustainable Development (2005–2014) compared to ESD scope of contents presented in Agenda 2030 Sustainable Development Goals.

UNESCO 2005 [DESD 2005–2014] **15 strategic perspectives**	**UNESCO 2020 [Agenda 2030 SDGs]** **17 learning goals**
Human Rights	1. No Poverty
Peace and Human Security	2. Zero Hunger
Gender Equality	3. Good Health and Well-Being
Cultural Diversity and Intercultural Understanding	4. Quality Education
Health	5. Gender Equality
HIV/AIDS	6. Clean Water and Sanitation
Governance	7. Affordable and Clean Energy
Natural Resources (Water, Energy, Agriculture, Biodiversity)	8. Decent Work and Economic Growth
Climate Change	9. Industry, Innovation and Infrastructure
Rural Development	10. Reduced Inequalities
Sustainable Urbanisation	11. Sustainable Cities and Communities
Disaster Prevention and Mitigation	12. Responsible Consumption and Production
Poverty Reduction	13. Climate Action
Corporate Responsibility and Accountability	14. Life below Water
Market Economy	15. Life on Land
	16. Peace, Justice and Strong Institutions
	17. Partnerships for the Goals

Note. Adapted from UNESCO. (2004). United Nations Decade of Education for Sustainable Development 2005-2014. Draft Implementation Scheme. UNESCO: Paris. Retrieved from portal.unesco.org/education/en/file_download.php/03f375b07798a2a55dcdc39db7aa8211Final+IIS.pdf. and from United Nations. (n.d.). Department of Economic and Social Affairs. Sustainable Development. https://sdgs.un.org/goals

Focused examination on the role of education within the SDGs themselves, reveals further epistemological incoherency and ambiguity that in turn, pose barriers to CC curriculum development and implementation. Table 4.1.2 demonstrates the ambiguity in relation to SDGs 4, 12 and 13, their Targets and Goals. These three SDGs include Indicators specifically addressing ESD.

Table 4.1.2.

References to education in SDG goals, targets and indicators

Goal	Target	Indicator
4 Quality Education	4.7	
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development	Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education and (d) student assessment
12 Responsible Consumption and Production	12.8	Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
Ensure sustainable consumption and production patterns	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	
13 Climate Action	13.3	Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
Take urgent action to combat climate change and its impacts	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	

Note. Adapted from United Nations. (n.d.). Department of Economic and Social Affairs. Sustainable Development. https://sdgs.un.org/goals

Examination of Table 4.1.2 reveals that the indicators of three different targets in three different SDGs are the same. This basically means that there is no way to distinguish which of the three targets was achieved, by implementing these indicators for evaluating the achievement of the three SDGs. From a curricular perspective, assessment that is incapable of identifying what knowledge was acquired is not fit for purpose. Further in-depth examination of the targets and indicators reveals more inconsistencies and ambiguities. For example, Target 4.7 states that "all learners acquire the knowledge and skills needed to promote sustainable development, … through education for

sustainable development and sustainable lifestyles, human rights, gender equality, …" (UN, n.d.). Here in SDG4, ESD is conceptualised as a means for acquiring a set of attributes alongside other means such as sustainable lifestyles, human rights, etc., unlike ESD conceptualisation in the DESD strategic framework (UNESCO, 2005), where ESD was conceived to include human rights, gender equality and the like. Similarly, the associated indicator differentiates between two separate vehicles for achieving the goal. These are ESD and Citizenship Education. This conceptualisation is inconsistent with UNESCO's earlier conceptualisations of ESD, where ESD was all inclusive. Finally, there are misalignments within the SDGs themselves, as the indicators appear conceptually disconnected from the targets they aim to measure. For example, while Target 13.3 discusses, among other things, the raising of institutional capacity on climate change mitigation, adaptation, impact reduction and early warning; the indicator measures only the extent of educational dissemination by measuring its presence in national education policies, curricula, teacher education, and student assessment. It is not clear how this indicator could possibly provide useful information on early warning signs and raising institutional capacities by using the aforementioned data collection.

Even more surprising to note is that while ESD was announced as an enabler for all SDGs, and appears in three indicators, the examination of the "Progress towards the Sustainable Development Goals", developed by the United Nations Economic and Social Council (UN, 2022), reveals no mentioning of ESD. It appears that no data was collected on ESD in relation to monitoring the progress on SDGs. These issues associated with the ESD agenda have drawn various criticisms, as discussed in what follows.

4.1.3.3. Critiquing the Suitability of the ESD Agenda to Act as a Host for Climate Change Curriculum

ESD and its associated terms received a variety of criticism over the years. UNESCO, acknowledged the criticism that "ESD has received for its 'vagueness', which stems in part from its broad and inclusive perspective and the ever-changing nature of sustainability issues" (UNESCO, 2020, p. 57). Further criticism was summarised in Eilam (2022), as follows:

> González-Gaudiano (2005) describes ESD perspectives as "[an] elusive thematic group of issues" (p. 243), made up of various fields of knowledge, each having its own identity and autonomy as a field. ESD provides an empty space of congregation for the various fields, and in turn becomes an "empty signifier" (p. 245). When co-opting these various autonomous fields into this makeshift shared space, they become deformed and obscured. The connections between these fields may go either way—positive or negative—or have no connection at all. For example, it can easily be seen how market economy may pull in an opposite direction to corporate responsibility; or HIV/AIDS may

> be unrelated to both market economy and corporate responsibility. Furthermore, there are no rules and regulations that govern the ways in which the empty space is filled, and therefore it can mean different things to different people, with meanings always being transitory and subject to permanent questioning (p. 246) (p. 6).

ESD knowledge appears as ephemeral, anecdotal with no rules and concepts of organisation. Contrarily, CC has evolved over the past 100 years as an organised body of knowledge with rules for determining claims of truth, and well-defined concepts and principles that govern the knowledge production. These differences may be demonstrated when comparing concepts in CC and in ESD. At a very basic CC level it is easy to demonstrate how, for example, the concept of greenhouse gas heat absorption is underlined by the scientific rule of molecular vibration and re-emission of infrared energy. We can make a claim of truth as to whether a substance is a greenhouse gas or not on the basis of whether or not it follows this rule. This is not the case in ESD. An SDG such as SDG16 Peace, Justice and Strong Institutions is merely an incidental assembly of ideas forming part of an agenda. The absence of such governing rules and principles is not a minor issue in ESD. Rules determine truthfulness. That is, claims of truth are judged by the extent to which they adhere to the consensual rules and principles of the field of knowledge. In the absence of rules, claims for truth cannot be refuted or verified, thus leading to a relativist worldview, where all claims are equally valid. Such is the case, for example, when BP, a company responsible for the emissions of 340 million tonnes CO2 equivalents per year in 2020 (Global Data, n.d.), can safely claim on their website that “Our purpose is reimagining energy for people and our planet. We want to help the world reach net zero and improve people’s lives” (see https://www.bp.com/en/global/corporate/who-we-are/our-purpose.html). Under the ESD framework, such claims are un-refutable, and may be accepted as truths.

While CC knowledge is expanding and being continuously revised, in a typical disciplinary characteristic, the basic concepts that constitute this body of knowledge present relative stability over time. No such stability can be attributed to the various ESD challenges. Not even at the basic level of terminological stability. Consequently, Kwauk (2020) questions ESD epistemology altogether, stating that “it is still unclear whether ESD is meant to be an orienting principle, an actual subject, or an umbrella term encompassing environmental education, climate change education, and other permutations of ecologically-oriented disciplines” (p. 11). Eilam (2022) noted that “if sustainability is no more than neologism, it seems self-evident that the notion of sustainability education is an unsuitable platform for hosting CC education. It does not provide a framework for coherent, comprehensive, knowledgeable and effective CC teaching and learning” (p. 6).

In moving beyond the epistemological issues associated with ESD, it has also received critique related to its axiology. It was suggested that the ESD agenda creates dangerous opportunities for corporates and interested actors in the neo-liberal market to justify continuous economic growth, by reinterpreting and moulding the sustainable development approach to support their interests and undermine efforts to seriously address CC (Hove, 2004, in Stein et al., 2022; Waldron et al., 2019). ESD was criticised for: (a) directly cultivating the neo-liberal stance in relation to the economy (Stein et al., 2022); and (b) for its instrumental and anthropocentric approach to nature, where the dominant ESD view conceives nature as a 'resource' (Kopnina, 2012; Sauvé, 1996). A poignant critique by Selby and Kagwa (2010) summarises this line of critique, stating that ESD has taken a neo-liberal marketplace worldview that "tacitly embraces economic growth and an instrumentalist and managerial view of nature that goes hand in glove with an emphasis on the technical and the tangible rather than the axiological and intangible" (p. 37).

This orientation seems to have filtered down to curriculum development. Aikens and McKenzie (2021) analysed ESD conceptualisation in the curricula of two Canadian provinces and noted that ESD curriculum documents convey the message that the environment is a 'resource', and that environmental degradation is a problem of management, which can be fixed while maintaining the current economic paradigm. Selby sums up the problem by stating that ESD "has become part of the problem rather than part of the solution" (Selby, 2010, p. 36).

4.1.4. Tensions Related to Climate Change Education Implementation

4.1.4.1. Conceptualising Climate Change Curriculum: An IPCC-Base Framework *Versus* the ESD Agenda Framework

Various scholars have noted the peculiar dichotomy that exists between CC conceptualisation within the ESD framework, and its conceptualisation by scientists from a disciplinary perspective. The peak international body representing the well-organised and conceptualised CC knowledge is undoubtedly, the IPCC. The IPCC (IPCC, n.d.) has developed numerous CC reports over the years. These reports are based on sound methodologies, which lay out the scope of contents and key CC concepts in what can be understood to represent a disciplinary framework for CC. While it seems appropriate to turn to these reports as reliable resources for informing CC curriculum development, Kranz et al. (2022) noted that the IPCC reports are rarely addressed in the context of school CC education. In their review of 75 CC education interventions at schools, they found a worrying gap between CC research discourse and its representation at schools. They noted that

> it is striking that very few interventions introduce students to … official political documents or the IPCC reports. This is surprising as these documents describe the

> scientific and political consensus on mitigation actions and are thus a relatively solid knowledge base for educational intervention (Kranz et al., 2022, p. 4194).

Similarly, Waldron et al. (2019) note a dichotomy in CC perception between teachers and students as compared to specialists. One of the noted differences was that teachers and students tend to frame CC as a problem to be solved by individual actions, ignoring the social and collective complexity of climate change; where this is not the case with specialists who conceive CC as system problem, which individual actions are not capable of solving. It appears that this dichotomy may be attributed to the cultivation of individualistic neo-liberal approach to CC by the ESD agenda.

In addressing the insufficient CC content in the National Curriculum in England, Hicks et al (2013) noted the need to "ensure that the National Curriculum remains informed by the most current and high-quality knowledge created in Universities and Research Institutes" (p. 7). This suggestion may be viewed as opposed to deriving curricula materials from non-evidence-based literature, such as UNESCO's publications concerning CC.

Furthermore, it is likely that the generalist and vague approach to ESD may be getting in the way and muddling the facts, drifting CC education away from its evidence-based sources. This may be exemplified by comparing the ways in which the IPCC and the ESD framework, define the term *mitigation.* In IPCC, the term *mitigation* is defined as follows: "A human intervention to reduce emissions or enhance the sinks of greenhouse gases" (Intergovernmental Panel on Climate Change [IPCC], 2018, n.d.). The term *mitigation measures* is defined as: "In climate policy, mitigation measures are technologies, processes or practices that contribute to mitigation, for example, renewable energy (RE) technologies, waste minimization processes and public transport commuting practices" (IPCC, 2018, n.d.).

Contrarily, within the ESD framework, Mochizuki and Bryan (2015), in presenting UNESCO's Climate Change Education for Sustainable Development (CCESD) programme, define *mitigation* as follows:

> Climate Change Mitigation is defined by the United Nations as a human intervention to reduce the sources of greenhouse gas emissions primarily linked to human actions of production and consumption (UNESCO/UNEP,2011). Mitigation efforts include a range of interventions to stabilize and reduce greenhouse gas concentrations such as: investing in renewable, non-polluting energies and designing greener technologies, conserving energy, promoting changed consumption patterns and lifestyles, and re-orienting economies, social structures, value systems and ideologies that have resulted in the emission of excessive greenhouse gases.

The comparison of the two definitions reveals that in the ESD version of *mitigation*, a range of unsubstantiated factors were added to the original IPCC definition, including: "conserving energy,

promoting changed consumption patterns and lifestyles, and re-orienting economies, social structures, value systems and ideologies that have resulted in the emission of excessive greenhouse gases". Most of these added factors relate to personal individual behaviours, representing unsubstantiated ideological assumptions and generic slogans calling to reorient the economy and change social structures, while at the same time in a typical neo-liberal fashion, they lay the responsibility for change on individuals. None of these claims are supported by any of the IPCC reports, as the evidence clearly suggests that personal behaviour is either not correlated, or negatively correlated with carbon emission reductions, and has no bearing on CC mitigation (Kranz et al., 2022). It is interesting to note in this context that Mochizuki, the lead author in Mochizuki and Bryan (2015), acts as a Programme Specialist in the UNESCO Section of ESD.

4.1.4.1. Tension between the ESD Agenda and the Content-Based Curriculum

In another section of the report, CC implementation in schools is discussed extensively, revealing overall poor implementation across the world (UNESCO, 2021a). This section addresses the theoretical underpinning of the problem. In particular, it focuses on the conceptual clashes between the ESD agenda and *content-based* curriculum, where the two frameworks are at odds with each other (Blum et al., 2013).

Empirical studies reveal that CC application in the context of ESD suffers from a range of curricular integration problems (SchoolEducationGateway, 2022), including fragmentation and disconnection from basic curriculum frameworks that may give CC its scope, purpose and conceptual framework. When considering the two dominant curricular types, *content-based* curriculum and *capacities-based* curriculum, there is an inherent unresolvable tension between *content-based* curriculum and ESD. This is because for the *content-based* curriculum to work, the teaching must be organised around knowledge. Since ESD is not a knowledge-based agenda, but rather a problems-based agenda, it may become extremely difficult to fit this agenda into the curriculum, particularly when it calls for reorienting the curriculum (UNESCO, 2017). Particularly, when in essence, the ESD agenda delegitimises the existing curricula.

When it comes to the *capacities-based* curriculum, the clash is much less apparent. Since the *capacities-based* curriculum is organised around objectives and not around knowledge, theoretically it should be much more receptable to ESD. However, as Young and Muller (2010) noted, the reality is that although many curricula across the world pronounce themselves to be *capacities-based* curricula, in effect, disciplines continue to dominate curricula, even when at the declarative levels they claim otherwise. Consequently, while theoretically these curricular frameworks are expected to be more receptive to implementing ESD, in practice this rarely occurs.

The inherent tension between *content-based* curriculum and ESD application was noted in a number of recent studies. For example, a report by the European Commission (2022) explains the low uptake of ESD by the education systems in the European Union, highlighting this tension, as follows: "Given the interconnected nature of learning for sustainability, the structuring of curricula around single subjects appears to be a barrier to further embedding environmental sustainability" (European Commission, 2022, p. 18). While the report perceives the barrier as the *content-driven* curriculum, here the opposite is suggested—that the barrier is the ESD agenda rather than the curriculum framework. Blum et al. (2013) in their comparative survey of Denmark, Singapore, Canada and the UK policy uptake of ESD and CC, also noted this inherent tension between *content-based* curriculum and *capacities-based* curriculum in relation to the inclusion of ESD.

Different countries take different approaches to resolving these tensions. Some countries resolve this tension by including ESD as an almost separate entity aside from their *content-based* curriculum, where ESD with its CC contents are not examined, have no benchmarks and do not present typical curriculum characteristics. In Singapore, for example, Singapore Green Plan 2012 (MEWR, 2002) does not provide any guidelines as to how ESD should be incorporated in the curriculum. In Denmark, pressures from NGOs and stakeholders led the government to develop a national strategy for ESD in 2009. However, the authors note the hesitation by the Ministry of Education to engage in ESD, due to the epistemological problems that ESD poses. They describe this hesitation as "grounded in the priorities of the Ministry, which at the time were focussed on moving 'back to basics' in core subject areas and were therefore somewhat in contrast to ESD's interdisciplinary approach" (Blum et., 2013, p. 212).

In other countries, the lack of clear conceptualisation of ESD has led to different government and non-government bodies taking different approaches to addressing the matter, at times, at odds with each other. Interestingly, Blum et al. (2013) note that while their cross-country comparison revealed multiple conceptualisations and approaches to ESD and CC education, in no country were there reports about successful implementation. In many countries ESD, 30 years after its appearance on the world stage, is still mostly implemented by NGOs, focusing mainly on awareness raising rather than on any specific content learning (Blum et al., 2013; UNESCO, 2020).

Overall, it appears that CC association with ESD forms a major obstacle for effective CC curriculum development (Blum et al., 2013). Selby and Kagawa (2010) clearly and unapologetically call policy developers to steer away from conceptualising CC as a topic of ESD, suggesting that "recent calls for the integration of climate change education (CCE) within mainstream education for sustainable development should be resisted" (p. 37). The broad evidence presented thus far suggests that CC

curriculum is more likely to fulfill its purposes effectively when organised around knowledge, not when organised around agendas and periodic challenges, as is the case of the ESD and SDGs agendas.

4.1.5. Footnotes Concerning ESD Educational Discourse

Before turning away from UNESCO and its ESD, and focusing on CC curriculum, it seems appropriate here to question some additional ideas often associated with UNESCO's conceptualisation of ESD. These include: *The cross-curriculum approach,* the discourse of *learning*, transformative education, the Idea of 'Think Globally—Act Locally', and finally *cognitive learning*, *socio-emotional learning* and *behavioural learning*. While the purpose of this report is not to carry out a discourse analysis of UNESCO's publications, due to the bearing that this discourse has on shaping CC curricula worldwide, it seems appropriate to dedicate some paragraphs to addressing them through their broader educational context.

4.1.5.1. The Cross-Curriculum Approach

Leading international bodies and the majority of educators advocate the *cross-curriculum approach* for implementing CC education (e.g., European Commission, 2022; Mulvik et al., 2022; UNESCO, 2021a, b).

To date, to the best of knowledge, the majority of evidence suggests that the *cross-curriculum* approach for implementing ESD and CC education does not work. Very few countries actually implement this approach in their curricula, and when they do, it scarcely filters down into actual implementation (European Commission, 2022; UNESCO, 2021b). Kessler (2021) also notes that contrary to expectation, the approach is not successful in contributing "to raising youth concern for climate change across contexts" (Kessler, 2021, p. 3).

When addressing the discrepancy between cross-curriculum advocacy and its poor implementation success, the literature commonly tends to lay the blame on the curricula, schools, and teachers for not trying hard enough (UNESCO 2021a, b).

The reality is that the lack of success is grounded in theory and may be deducted from theories of learning (Sandoval, 2016), teacher knowledge (Carlone & Johnson, 2007), and Curriculum Theory (Young, 2013). It is beyond the scope of this report to delve into these theories and explain how this empirical evidence may be deducted from the current understanding of knowledge, curriculum, teaching, and learning. However, it is suffice to state here that while the *cross-curriculum approach* for implementing CC education may seem highly appealing for many educators, thus far this approach has not been substantiated theoretically and the empirical evidence for its success is poor.

On the background of the overwhelming evidence for minimal success, it is recommended that when applying the cross-curriculum approach for teaching CC, the Ministry of Education will take extra measures to monitor the application and conduct periodical assessments. This will provide the Ministry with appropriate evidence to work on and make corrections, as appropriate. It will also ensure that scarce resources are not spent wastefully and unaccounted.

4.1.5.2. Discourse of 'Learning'

UNESCO publications emphasise *learners* and *learning*. For example: "What ESD requires is *a shift from teaching to learning*" (UNESCO, 2017, p. 7). Similar statements refer to *lifelong learning*, *21st century learners and their skills*, and similar expressions putting the learning and learners at the centre, and moving teachers and teaching to the background, as *facilitators*. While this discourse has no direct bearing on CC curriculum development, like other discursive expressions, they represent UNESCO's broader educational outlook, which does have indirect bearing on CC, and thus may be worth addressing in this context. The eminent educational scholar, Gert Biesta has been expressing his concern regarding what he termed the *learnification* of education, since the early 2000's. According to Biesta, *learnification,* which is derived from the neo-liberal market-driven educational reforms, "refers to the shift in educational discourse, policy and practice toward learners and their learning and hence away from teachers, teaching and curriculum" (Biesta, 2022, pp. 42–43). He continues to explain that in fact "the term "learning" is actually a rather empty process-term which doesn't say much—if anything at all—about what the learning is *about* or what it is for. Yet these questions are crucial for education because the point of education is never that students simply learn" (p. 43). They do so anyway and anywhere. The problem with the *learnification* discourse is that it shifts attention away from the critical questions of content, purpose and teaching relationships, making these questions invisible. When it comes to the teaching relationships, Biesta asserts that "learning is accidental to education, teaching … is essential to education" (p. 62). In other words, while learning originates from the student, teaching comes from elsewhere *to the student**s***, and plays an essential role in education. Thus, the idea of the teacher as a "facilitator of learning", misconstrues the complexities of educational relationships and the work of the teacher in such relationships" (p. 43). Finally, he calls "for the rediscovery of teaching" (p. 62), with a view that the gifts of teaching have to do with curriculum and pedagogy.

In the context of CC curriculum development, this footnote comment draws attention to the importance of focusing on the teaching aspects of the curriculum, rather than on the tacit aspects of learning. Simply put: The curriculum needs to focus on what it is giving to the students, rather than on what the students will do or not do with these educational gifts.

4.1.5.3. Transformative Education

UNESCO unapologetically calls for transforming individuals, schools and societies. This re-education agenda permeates the organisation's publications. UNESCO further stresses that the question of "how to encourage learners to undertake transformative actions for sustainability has been a major preoccupation for ESD" (UNESCO, 2020, p. 57). Accordingly, the role of educators is to transform their students and help them understand "the complex choices that sustainable development requires and motivate them to transform themselves and society" (UNESCO, 2020, p. 30). Educators also need to understand "how transformative actions occur and which gender-transformative pedagogical approaches can best bring them about" (UNESCO, 2020, p. 30). Finally, UNESCO perceives as the prime educational goal for ESD, to enable "individuals to contribute to sustainable development by promoting societal, economic and political change as well as by transforming their own behaviour" (UNESCO, 2017, p. 7).

So what is *transformative education*?

The ESD literature proposed a few definitions. According to UNESCO (2017):

> transformation necessitates, among other things, a certain level of disruption, with people opting to step outside the safety of the status quo or the "usual" way of thinking, behaving or living. It requires courage, persistence and determination, which can be present at different degrees, and which are best sourced from personal conviction, insight, or the simple feeling of what is right (p. 57).

According to this definition when one student at the schoolground bullies their peer, this must be an act of transformation. As the student is clearly stepping outside the status quo. They are stepping outside of safety as they risk detention. They may also be persistent in their action and have a sense of conviction. To address this definitional pitfall, in 2019 UNESCO added a reservation by rephrasing *transformative education*, to become "responsible transformative engagement" (UNESCO, 2019, p. 2). Thus, not all transformative actions are now accepted. However, the question remains: Who decides what 'responsible' is? For example, in Australia, the Extinction Rebellion protesters are held by the police and prosecuted for violating public order, whereas in other countries, such as in Israel, these protests are considered legitimate and thus 'responsible'.

According to UNESCO (2019) "transformation refers to a change, more or less radical and deep, in form, nature or appearance" (p.3) ...

> For transformative engagement to take place, there has to be a moment where the learner perceives a gap, is awakened to a new reality and to facts/situations that were formerly part of their lives and about which they were not aware. The learner may then undergo an internalisation process, working on an observed gap. When such processes combine with a learner's understanding of how the others are experiencing that gap and

> there is a connection made both cognitively and emotionally, a learner may be brought closer to undertaking action and/or behavioural change. … In many cases, undertaking transformative action requires a tipping moment(s), when the learner sees the need for action to bridge a specific gap (p. 6).

According to this scenario, it seems reasonable to suggest that many teenagers are involved in transformative engagement. At some point they are awakened to the realisation that their parents are not perfect and all-knowing as they thought. In addressing this gap, the teenagers connect emotionally and cognitively with their peers and are led to go through a behavioural change and take action. Contrary to what they were taught at home, they responsibly engage in an illicit drug party. Beyond the cynicism, the point here, is that radical changes occur naturally through life to most people, either through crisis, natural growth, or other triggers. These milestones are mostly unpredictable, cannot be externally orchestrated and can lead people either way, on a positive or negative direction.

The European Commission (2022) offered their own definition as follows:

> When learners are encouraged to reflect and question knowledge acquisition, assimilate it, and put it into practice, transformative learning takes place. Such learning involves cognitive (head), psychomotor (hands) and affective (heart) domains and encourages reflection, questioning and action. Transformative learning is learner-centred, therefore promoting student agency (p. 100)

According to this definition, transformative learning occurs when a science teacher conducts a unit of work about water quality. She teaches students about biotic and abiotic factors affecting water quality. Students would go out into their local water systems and sample the water taking various measurements of quality indicators. They analyse the data and following further investigation they find that there is some nutrient run-off from a local farm, which negatively affect the water quality. Students decide to take action by notifying the local authorities regarding their findings. This exemplary unit of work has been considered as best-practice in science education since John Dewey's work in the early 20th century. It begs the question: What is transformative about learning that involves a range of emotional, physical and cognitive aspects interacting to create meanings?

Finally, I draw upon the detailed description of *transformative learning* provided by Mulvik et al. (2022), as follows:

> The alternative concept of transformative learning is well-established in education science, and is operationalised both educationally and methodologically. It encompasses two broad directions: "the approaches of transformative learning as a change in individual perspectives of meaning and the concepts of transformative learning as collective processes of awareness development and emancipation" (Singer-Brodowski, 2016). In the transformative learning process, experiences of failure result in the

> questioning of basic understandings and the creation of new realities, and therefore lead beyond the mere acquisition of knowledge and abilities to trigger changes in basic behaviour, feelings and thoughts. Transformative learning should focus on the process of building awareness of, questioning and further developing the individual's own perspectives (p. 19).

The first sentence in the citation claims that "transformative learning is well-established in education science, and is operationalised both educationally and methodologically" (p. 19). The reader does not receive an explanation as to what 'operationalised educationally and methodologically mean' and thus this aspect of the explanation remains obscure.

In moving on to the next part, the explanation suggests that there are two parts constituting the transformation. The first part occurs at the individual level and the second part at the collective.

Let's focus first on the individual. According to this text, individual transformation occurs when there is a change in "perspectives of meanings" (p. 19). This definition suggests that every time a person goes through conceptual development and acquires new knowledge and meanings, this person has been transformed. Across life, humans constantly acquire knowledge that changes their perspectives on issues. Thus, we can say that all of us continuously transform from birth to death. If so, how is it that these ongoing transformations have not yet led to the much sought-after sustainable world?

The collective aspect of the definition refers to some collective awakening and emancipation, which I will not delve into. Various religions may have much more to say about awakening people into "awareness" and "emancipation".

Finally, the last part of the citation discusses the role of failure in triggering "changes in basic behaviour, feelings and thoughts" (p. 19). According to this definition, failure leads to transformation. This suggests that if I have failed my course (at university) and decide to move to a different course, I have been transformed. Once again, it is not clear how these normal life events of failing may lead to the much sought-after sustainable world.

To summarise, the idea that students should be "transforming their own behaviour" (UNESCO, 2017, p. 7) seems alarming, as it suggests that students are essentially sinners that need redemption. Theoretically, *transformative learning* appears as an obscure and puzzling idea, as on one hand the various definitions seem to describe what education does anyway, and on the other hand *transformative learning* calls to disrupt education. Similarly, there is also inconsistency in the fact that on one hand, there is wide agreement that the role of schools is to provide students with the best knowledge, the best skills, the best values and overall the best experiences that societies can offer; and on the other hand, transformative education puts forward the expectation that students will undercut their learning, and in essence reject what they have learnt. More so, the

transformation idea at its essence suggests that schools are doing a bad job and that students should not be taking in what schools have to offer. This leaves us questioning: If schools cannot educate well, who can?

4.1.5.4. Considering the Idea of 'Think Globally—Act Locally' in Relation to Motivation for Action

In this footnote I touch on the issue of behaviour in CC education through the lens of addressing CC from a local *versus* global perspective. A separate dedicated chapter will explore the role of behaviour in CC education, more broadly.

Since the early inception of EE, the motto *think globally and act locally* found much credence among educationists. Kranz et al. (2022) found that the majority of CC school programs adhere to this notion, suggesting that students should take individual actions to mitigate CC in their local environments, particularly through individual actions. In recent years, increasingly researchers are questioning this slogan, using both theoretical frameworks and empirical evidence to examine this assertion. Here four lines of evidence are presented, disputing the motto.

The Construal Level Theory of Psychological Distance was applied in several studies as a useful framework for considering how the framing of CC at different distances from the individual may affect people's judgments concerning CC. The theory assumes that humans can only directly experience the present situation and that all other perceptions are mentally construed (Brügger et al., 2015, p. 1032). Accordingly, "people construe distant phenomena as abstract and proximal phenomena as concrete" (Armstrong & Krasny, 2020, p. 11). This framing can be investigated at different distance scales, including spatial, social, temporal and hypothetical. When it comes to CC, studies suggest that people tend to view CC as distant across the four scales. They typically view CC as something that affects strangers in remote times and places (Brügger et al., 2015).

Studies examining the impact of framing CC as a local problem on people's engagement and willingness to take action on CC found mixed results. While it seems sensible to believe that by presenting CC as an immediate threat, spatially and temporally would motivate people to take actions, studies suggest the opposite. It appears that proximising CC "fails to consistently translate into increased willingness to act on climate change and to support relevant policies" (Brügger et al., 2015, p. 1032).

When it comes to predicting people's behaviour, the Construal Level Theory suggests that values, which are regarded as broad mental orientations, are better at predicting behavioural intentions in the distant future, whereas behaviour intentions in the present are better at predicting by

considering the convenience of performing behaviours. Thus, people who hold values that support action on climate change, are more likely to act on them when they think of CC as a distant future problem rather than as a local present problem. For this group of people, the theory predicts that proximising CC would decrease their intention to act, because it draws their attention away from their values. Furthermore, when CC is presented to people as proximal, immediate and local, this provokes people to think about the costs-benefits associated with taking action on CC. This line of thinking leads to a realisation that taking concrete action may involve high personal costs with little benefits (Brügger et al., 2015).

Research in other fields of psychology suggest that proximising CC may fail to elicit action exactly for that same reason, by which CC becomes personally relevant. According to these studies, when people grow their understanding of CC and its implications on their daily lives, they become at risk of feeling overwhelmed or anxious. These unpleasant emotions, in turn, activate a range of psychological defence responses, particularly when people feel that the problem is too big for them to deal with. The range of responses may include apathy, scepticism, and other strategies for distancing one's self from the CC threat, such as avoiding information about CC and denying its relevance. These emotional responses deter people from taking actions on CC, as they operate to reduce the level of contact between the individual and the threatening issue (Feinberg & Willer, 2011; Feygina et al., 2010). Thus, proximising CC may act to exacerbate defensive mechanisms, which in turn act to reduce intention to act (Brügger et al., 2015).

Further psychological distancing may occur in response to media campaigns and educational programs, which cultivate individual *responsible behavior*. These may threaten the students' psychological resources, by reducing positive self-view. Brügger et al. (2015) explains that when people perceive their personal behaviours as harmful to their proximal environment, this leads to negative psychological consequences, described as follows:

> Sharing responsibility for causing harm implies that one is an irresponsible, uncaring and morally questionable person (Butler, 2010;). These implications may not only lead to unpleasant feelings such as guilt (Ferguson & Branscombe, 2010; Moser, 2007), they also conflict with people's desire to maintain a positive self-view (Steele, 1988). (Brügger et al., 2015, p. 1034).

An additional psychological stressor caused by the pressure to change individual behaviour is derived from the fact that people generally form attachments to their social milieu, their lifestyle and their immediate environment (Brügger et al., 2015). People who belong to a socio-economic group whose lifestyle is under attack, tend to respond to the criticism by adhering closer to their group and its lifestyle, as a defensive act. This defensive behaviour can be exemplified in people's

behaviour in relation to taking holidays overseas. The more the activity of flying for holidays are condemned for their damage to the environment, the more it is predicted that people would feel the need to protect this aspect of their lifestyle and carry on with these activities.

Overall, the findings suggest that proximising CC as a mean for motivating students to take action, would most likely be counterproductive (Brügger et al., 2015). However, this applies only when the construction of knowledge is purposefully used for serving the goal of behavioural change. Once education releases itself from the aim to change the students' individual behaviours, the risks associated with proximation no longer apply. In other words, when localising CC is dissociated from expectations to act, the problem of counter-productiveness no longer exists. In practical terms it means that the acquisition of CC knowledge regarding the local environment has an intrinsic value on its own right, acting as *powerful knowledge* (Young, 2013). However, educators should be mindful of not crossing the lines, by utilising the delivery of local CC knowledge, as means for serving purposes other than knowledge construction, such as motivating for action. Say from now: *Think globally—think locally*.

4.1.5.5. Cognitive Learning, Socio-Emotional Learning and Behavioural Learning in the Context of the Sustainability Agenda's Goals

ESD literature often distinguishes between three types of learning, which are termed *cognitive learning*, *socio-emotional learning* and *behavioural learning* (sometimes referred to as *action-oriented learning*) (UNESCO, 2021a,b).

UNESCO (2017) refers to these types as *domains* and defines them as follows: *The cognitive domain* "comprises knowledge and thinking skills necessary to better understand the SDG and the challenges in achieving it" (p. 11). *The socio-emotional domain* "includes social skills that enable learners to collaborate, negotiate and communicate to promote the SDGs as well as self-reflection skills, values, attitudes and motivations that enable learners to develop themselves" (p. 11). *The behavioural domain* "describes action competencies." (p. 11).

UNECO went a step further by specifying the specific capacities in each domain, as they apply to each SDG. For example, in SDG1 No Poverty, the socio-emotional objectives state that: "the learner is able to collaborate with others to empower individuals and communities to affect change in the distribution of power and resources in the community and beyond" (UNESCO, 2017, p. 12); and "the learner is able to reflect critically on their own role in maintaining global structures of inequality" (UNESCO, 2017, p. 12). Here UNESCO is suggesting that students who are socio-emotionally competent should be able to demonstrate the capacity to mobilise change in the power and resource distribution in society. As most people are not capable of demonstrating this capacity, it

may be deducted that this socio-emotional capacity is mostly unachieved. Regardless, it is expected that students demonstrate a capacity to reflect on their own negative impact in maintaining the existing structures, in an educational approach that seems to cultivate notions of sin and repentance.

UNESCO (2019) proposed a new set of definitions, as follows: The *cognitive* aspect relates to "acquire knowledge, understanding and critical thinking about global, regional, national and local issues, the interconnectedness and interdependency of different countries and populations, as well as social, economic and environmental aspects of sustainable development" (p. 7).The *socio-emotional* aspect relates to "have a sense of belonging to a common humanity, sharing values and responsibilities, empathy, solidarity and respect for differences and diversity, as well as feel and assume a sense of responsibility for the future" (p. 7).The *behavioural* aspect relates to "act effectively and responsibly at local, national and global levels for a more peaceful and sustainable world" (p. 7).

Mulvik et al. (2022) offer the following set of definitions, as follows: *Cognitive* "relating to knowledge, understanding and critical thinking" (p. 9). *Socio-emotional* "relating to a sense of common humanity, values and responsibilities, empathy, solidarity and respect" (p. 9) and *Behavioural* "relating to skills development" (p. 9).

The ESD literature suggests emphasising the socio-emotional and behavioural learning, as these cause changes in individual behaviour. In turn, individual behavioural change, is conceived as causally related to bringing about sustainability. In other words, ESD aims to cause sustainability, as its main goal, and one major way to achieve this is through individual behavioural change. This behavioural change can be achieved through the three above learning types. Some excerpts demonstrate this conceptualisation, as follows:

According to UNESCO (2017) "ESD can produce specific cognitive, socio-emotional and behavioural learning outcomes that enable individuals to deal with the particular challenges of each SDG, thus facilitating its achievement" (UNESCO, 2017, p. 8). UNESCO (2019) cautions that the three types of learning need to be balances, stating that

> less balanced ESD … approaches –such as a disproportionate focus on cognitive learning … may foster learners who will be less likely to alter their everyday actions and actively contribute to living in and building a more inclusive, just, peaceful and sustainable society (UNESCO, 2019, p. 7).

Accordingly, Mulvik et al (2022) suggest that "more emphasis should be placed on the dimensions of social and emotional and behavioural learning. To increase knowledge, skills and attitudes relevant

to creating sustainable behaviour, pedagogies must be adjusted towards practising and instilling such behaviour" (p. 25). They further conclude that

> the emphasis on the cognitive/academic dimension and the de-emphasis of the social and emotional and behavioural dimensions creates a situation in which students are able to pass standardized exams on ESD and Global Citizenship Education (GCED), but not to develop lasting emotional commitments or the behavioural skills relevant to applying ESD and GCED (p. 24).

This conceptualisation has a series of flaws that require addressing. This first is the unsubstantiated assumption that individual behavioral change can bring about sustainability and that individuals have the power to mobilise change on their own (Powdthavee, 2020). This false assumption is dealt elsewhere in this report. A second problematic assumption is that it is the role of the education system to bring about sustainability. Many would argue that the role of education is to educate children, and not to be used as means for alternative motives and agendas. That is, if society wishes to change, it can do so by itself, without recruiting the education system as its vehicle (Biesta, 2022). This is particularly the case as society itself does not yet have a clear idea as to what sustainability might look like, and there is no agreement regarding the path that needs to be taken. Thus, it is not clear what sustainability teaching actually entails. According to this view, learning about CC and human impact on the environment is a highly important educational goal on its own right. However, this purpose may be lost when the educational goal becomes a mean for external non-educative purposes, such as students fixing the world.

Regarding the distinction between cognitive, social-emotional and behavioural learning. This distinction is neither discussed, nor theoretically substantiated. There is no explanation as to how the three types of learning differ; how they differ in relation to their respective learning outcomes; and how they can be measured. Examination of education literature further increases concerns regarding the validity and the meaning of these terms. From a cognitive psychology perspective, these terms are at odds with theories. Current research suggests that there are no distinguishable brain processes that differentiate between cognitive and emotional epistemic. Various definitions of the term *cognition* include emotional aspects, built into the definitions and form part of cognition. For example, Greene and Yu (2015) proposed to define cognition as "a process involving dispositions, beliefs, and skills regarding how individuals determine what they actually know, versus what they believe, doubt, or distrust" (Greene & Yu, 2015, p. 46). Expressions such as doubt, or distrust inevitably involve emotional aptitudes. These processes seem to be intertwined, manifesting "complex relations between epistemic cognition, epistemic emotions, and critical thinking" (Muis et al., 2021, p. 1). This intertwining of cognition and emotions is further demonstrated in Muis et al.'s (2021) definition, describing emotions as "interrelated psychological processes that include affective

(e.g., feeling nervous), cognitive (e.g., ruminating thoughts), motivational (e.g., a desire to escape), expressive (e.g., displaying a frown), and physiological (e.g., increased heart rate) components (Ellsworth, 2013; Shuman and Scherer, 2014)" (p. 4). Lisa Feldman Barret (2017) in her Theory of Constructed Emotions takes this notion further and eliminates altogether the distinction between cognition and emotions. For her, *emotions* are simply *concepts*. These concepts are dependent on a combination of physical properties, the flexibility of the brain to respond to its environment, and "the culture and environment in which emotional responses evolve and operate" (Barret, 2017, p. xii). In recent years the growing understanding regarding the role of the body in learning and cognition further highlights the intertwined behavioural aspects of learning. Foglia and Wilson (2013) emphasised the role of embodied cognition, suggesting that "mounting empirical evidence shows that bodily states and modality-specific systems for perception and action underlie information processing, and that embodiment contributes to various aspects and effects of mental phenomena. (Foglia & Wilson, 2013, p. 319).

Taken together, it appears that the distinction made between cognitive, socio-emotional and behavioural learning, represents a positivist reductionist understanding of learning, that does not have credence in evidence-based research. These terms seem to be hanging loosely, where the typological distinction is unable to provide evidence as to how these so-called categories of learning, can be taught separately, learnt separately and assessed separately, as constructs that represent meaningful understanding of the educational process. Thus, the three different terms are misleadingly used to describe the same process—*learning*.

4.1.6. Summary

The review of the literature revealed that worldwide the two dominant curricular types are *content-based* and *capacities-based* curricula. The *content-based* curriculum is more traditional, and it is organised around disciplinary knowledge, whereas *capacities-based* curriculum is often associated with the neo-liberal economy, and it is organised around capacities deemed worthy by the society and the economy. It is suggested that various ideas associated with the capacities-based curriculum are not theoretically and empirically evidence-based, posing challenges to effective curriculum development. Various curricula reforms are now beginning to move away from *capacities-based* curriculum and bring back the knowledge to the centre. Here it is recommended that CC curriculum development will follow suit, by organising the curriculum around knowledge and concepts, rather than general capacities.

The epistemology of CC as a body of knowledge is under-investigated. There is no shared conceptualisation and even no shared terminology. This report suggests conceptualising CC as a

discipline. The review further reveals that the ESD agenda may act as a barrier for effective conceptualising and development of CC curricula. ESD is defined in this report as: Agenda for solving the world's major problems as they are understood at any given time. This agenda appears as unfit to forming a basis for CC curriculum development, and thus it is recommended to dissociate CC curriculum from the ESD agenda.

Finally, the evidence suggests that the cross-curriculum implementation approach is ineffective for a range of reasons. Primarily because it does not allow for systematic and organised construction of CC knowledge. This is caused by the fragmentation and dispersal across multiple subjects. The following chapter expands further on the ways in which nations include CC in their curricula.

4.2. SURVEY of Climate Change in National Curricula

4.2.1. International Comparative Evaluation of Climate Change Presence in National Curricula

In recent years, intergovernmental organizations and researchers have been conducting surveys comparing CC presence across national curricula. In what follows I first present large scale international comparative curricula surveys. These are organized according to the surveys' scale from the largest sample sizes to the smallest sample sizes. This is followed by presenting curriculum analysis of specific countries, including: (i) USA and its 50 states, with a focus on the Next Generation Science Standards (NGSS), New Jersey and California CC curricula; (ii) Canada and its 13 provinces and territories; (iii) England; (iv) Ireland; and (v) Singapore. Finally, conclusions are drawn in relation to CC presence in national curricula.

4.2.1.1. Summary of UNESCO (2019) Study Entitled "Country progress on climate change education, training and public awareness. An analysis of country submissions under the United Nations Framework Convention on Climate Change section of education for sustainable development".

In this large-scale study, UNESCO in collaboration with UNFCCC analysed 194 countries submissions to the UNFCCC, as part of their reporting commitments. Two types of submissions were analysed. The first is National Communications (NC), which are submitted every four years to UNFCCC Secretariat and report on countries' progress to date in addressing CC. The second submission is the Nationally Determined Contributions (NDCs), which are submitted every five years, as part of countries' obligations to the Paris Agreement (2015). The NDC submissions consist of countries' reports on their actions to reduce carbon emissions and their future implementation plans for progression relative to their commitments. A total of 368 country submissions, consisting of 196 NCs

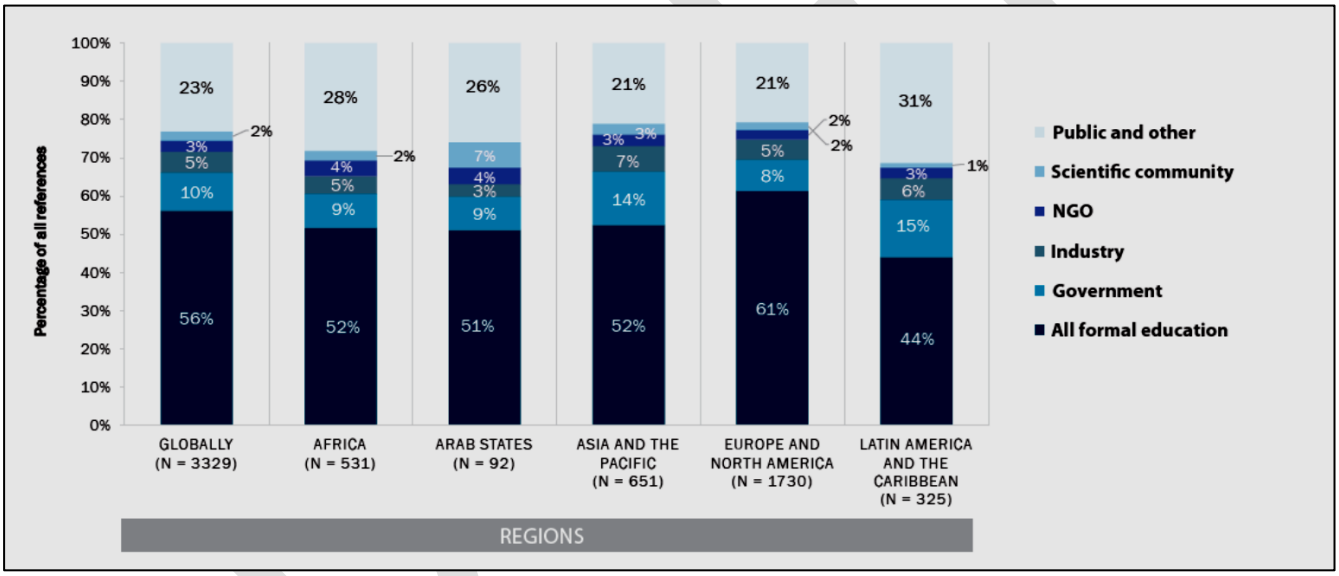
and 172 NDCs were analysed. Together, the reports obtained from 194 countries comprise 98 per cent of all 197 parties to the UNFCCC. The aim of the analysis was to examine how CC education is addressed in countries' submissions.

The findings revealed that 95 per cent of the countries included some CC education content in their submissions. However, this content was mainly descriptive and aspirational.

The analysis showed that over 50% of CC education mentioning was in relation to the formal education. Figure 4.2.1 reveals that apart from the formal education sector, the other target audiences for CC education include: Public and Other; Scientific Community; NGO; Industry; and Government. the target audience Public and Other is the next largest audience after All Formal Education.

Figure 4.2.1.

Target audience of climate change education, globally and by region



Note. Reprinted from "Country progress on Climate Change Education, Training and Public Awareness. An analysis of country submissions under the United Nations Framework Convention on Climate Change Section of Education for Sustainable Development", by United Nations Educational, Scientific and Cultural Organization (UNESCO), 2019, (https://unesdoc.unesco.org/ark:/48223/pf0000372164), p. 6. Copyright 2021 by UNESCO Education Sector.

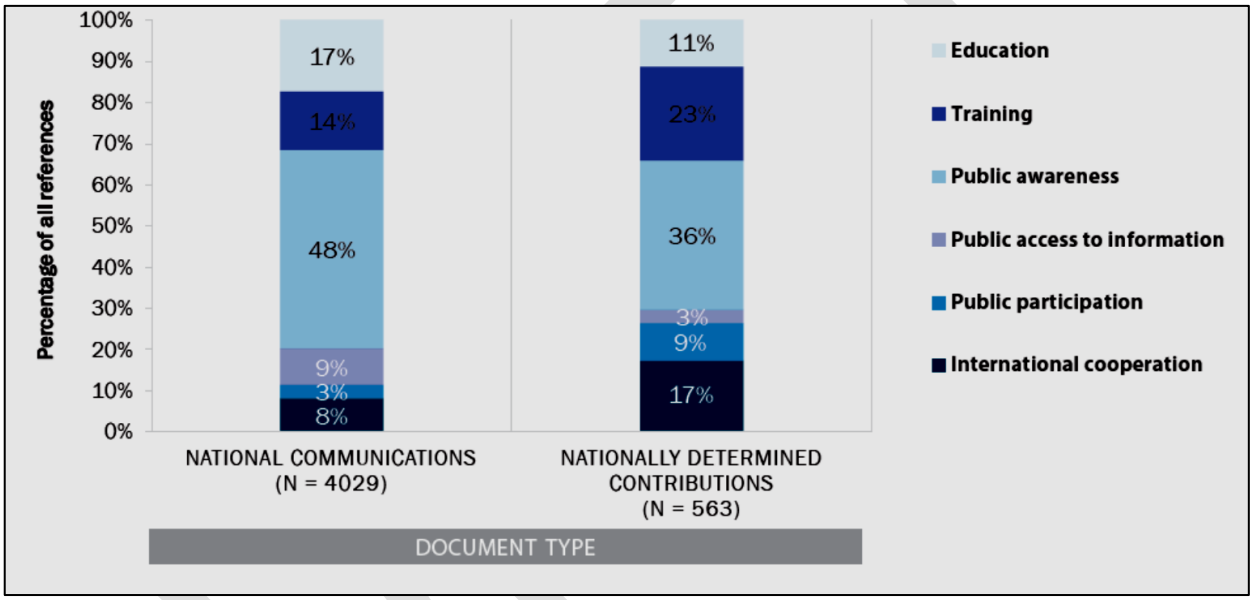
Examination of the type of approach applied in relation to CC education, reveals that Public Awareness was the most common approach discussed overall (48% of NC references and 36% of NDC references). Education (defined as formal education) was mentioned only in 17% of NC references, and in 11% of NDC references. Figure 4.2.2 presents the various types of approaches in

percentage of application, by submission type. None of the submissions specifically explained what Public Awareness entails or how it is measured.

Only 30% of the documents included any quantitative data that may be used for monitoring progress in CC education, with half of these focusing on Public Awareness. Only 7% of the documents included quantitative data on formal education. This was primarily in relation to ESD or Global Citizenship Education. Key word searches that examined the relative abundance of the term Environmental Education compared to ESD found that 72% of the submissions used the term Environmental Education as compared to 26% that used the term ESD.

Figure 4.2.2.

Climate change education approaches in National Communications and Nationally Determined Contributions



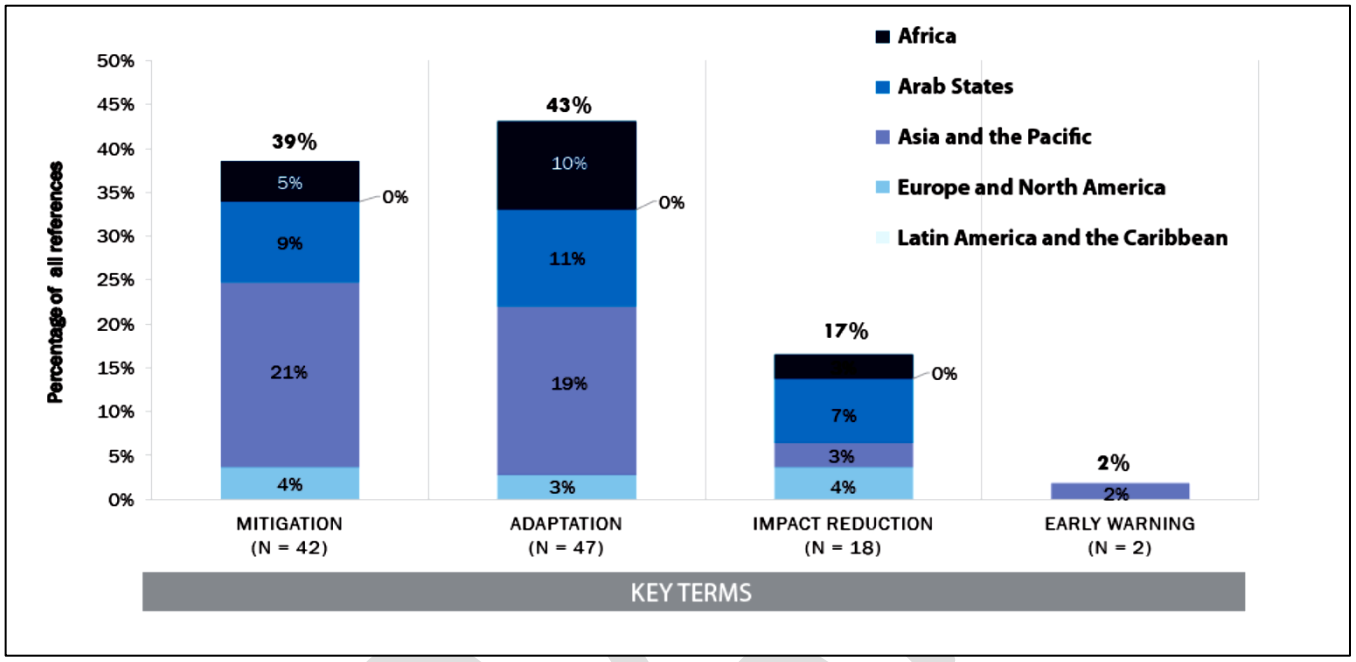
Note. Reprinted from "Country progress on Climate Change Education, Training and Public Awareness. An analysis of country submissions under the United Nations Framework Convention on Climate Change Section of Education for Sustainable Development", by United Nations Educational, Scientific and Cultural Organization (UNESCO), 2019, (https://unesdoc.unesco.org/ark:/48223/pf0000372164), p. 7. Copyright 2021 by UNESCO Education Sector.

Only 13% of the countries' submissions addressed a specific CC responses, with the strongest focus on adaptation and mitigation. Figure 4.2.3 presents the percentage of CC responses by region. Note that the data represents only 13% of countries who reported a response type. Furthermore its application to the education system is unknown. Particularly due to the fact that relatively small

percentage of references address the formal system and much fewer submissions provide quantitative data.

Figure 4.2.3.

Climate change responses by regions



Note. Reprinted from "Country progress on Climate Change Education, Training and Public Awareness. An analysis of country submissions under the United Nations Framework Convention on Climate Change Section of Education for Sustainable Development", by United Nations Educational, Scientific and Cultural Organization (UNESCO), 2019, (https://unesdoc.unesco.org/ark:/48223/pf0000372164), p. 9. Copyright 2021 by UNESCO Education Sector.

In conclusion, while most countries mentioned CC education in their UNFCCC submissions, this was mainly related to Public Awareness, with only 17% of NC references and 11% of NDC references addressing the formal education system. This suggests that in most of the countries in the world, little progress has been done to the date of this publication, in relation to developing and implementing CC curricula. Furthermore, the scarce quantitative data provided in the countries' submissions limits the ability to conduct global monitoring of countries' progress in implementing CC education.

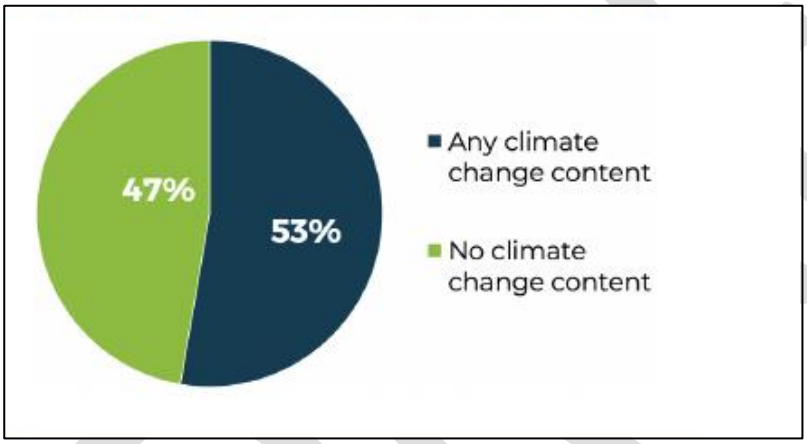
4.2.1.2. Summary of UNESCO (2021a) Survey Entitled "Getting every school climate-ready. How countries are integrating climate change issues in education?"

A survey conducted by UNESCO in 2021, focused on evaluating the presence of CC education in national curricula. The review analysed 129 curriculum documents obtained from 100 UNESCO Member states from geographically diverse locations. The curricula were searched for key terms related to CC, including greenhouse gas, global warming, climate change, climate crisis, and carbon.

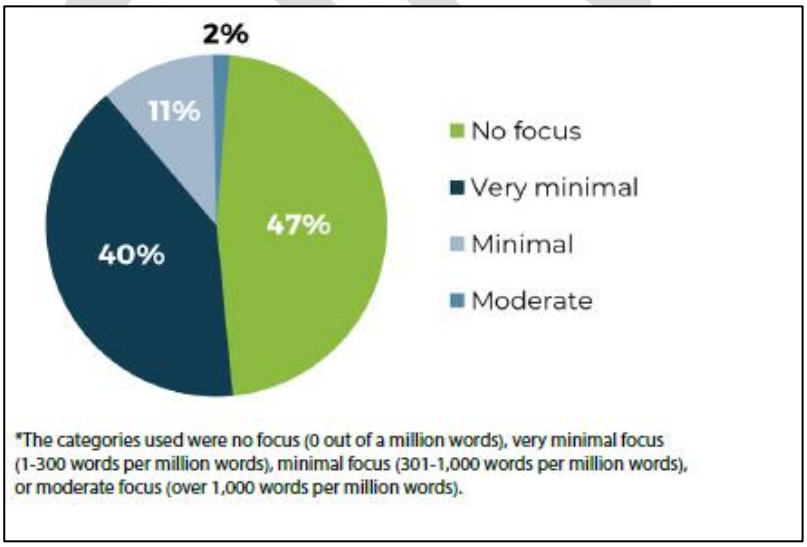
The findings revealed that 47% of national curricula had no reference to CC whatsoever. The rest of the curricula mentioned CC in a very shallow way. Figure 4.2.4 Presents the percentage of documents with CC mentioning and the extent of CC focus in documents were CC was mentioned.

Figure 4.2.4.

Percentage of documents with any climate change content (a); and percentage of documents by extent of climate change focus (b)



A. Percentage of documents with any climate change content



B. percentage of documents by extent of climate change focus

Note. Reprinted from "Getting every school climate-ready. How countries are integrating climate change issues in education", by United Nations Educational, Scientific and Cultural Organization

(UNESCO), 2021a, (https://unesdoc.unesco.org/ark:/48223/pf0000379591), p. 4. Copyright 2021 by UNESCO: Paris.

The findings suggest that CC is primarily addressed in biology, science, and geography. This finding has been confirmed in multiple other studies (e.g. UNESCO, 2021b)

It was reported that only 40 per cent of national education laws and 45 per cent of education sector plans or strategies explicitly refer to CC education. The report mentions Italy as an exceptional exemplar. Italy has over 100 laws and legislative decrees that refer to climate change. As of 2020, climate change education became mandatory as part of civics education, across all levels of education starting from the 2020/21 school year. Additionally, CC is mentioned in the geography and biology curricula and is also included in the curriculum guidelines' underlying principles. The report accredits this achievement to a successful collaboration between the Ministry of Education and the Ministry for the Ecological Transition (equivalent to the Ministry of Environment), describing how "the two ministries jointly published Guidelines for Environmental Education and Sustainable Development in 2015. The guidelines address climate change and state the government's intention to educate a generation of "environmental natives."" (p. 9). A similar collaboration between the Ministry of Education and the Ministry of Environment was reported in Colombia.

The report further mentions Indonesia, which in 2013 made a decision to include CC as a core competence in its national curriculum, as part of the attitudes, skills, and knowledge that students should achieve.

The Republic of Korea published a Masterplan on Environmental Education (2020), which includes a strong focus on CC. The Masterplan outlines the total budget for the Ministry of Environment's environmental education projects for 2021-25 – amounting to USD 15.5 million. CC is integrated across the national curriculum framework.

The report provides a range of recommendations, including recommending that CC be included in all national curricula as a core component. CC should be included across all year levels and disciplines, including in teacher training courses, stating that "Climate change education should be integrated into pre-service and in-service teacher training in all subjects and at all levels of education. Knowledge, effective pedagogies and tools should be provided to encourage a whole-school approach to climate education" (p. 12). These ideas are typical to UNESCO's approach and are critiqued elsewhere in this report for their lack of theoretical and empirical evidence. Finally the report recommends that Ministries of Education and Environment work together to enhance CC education.

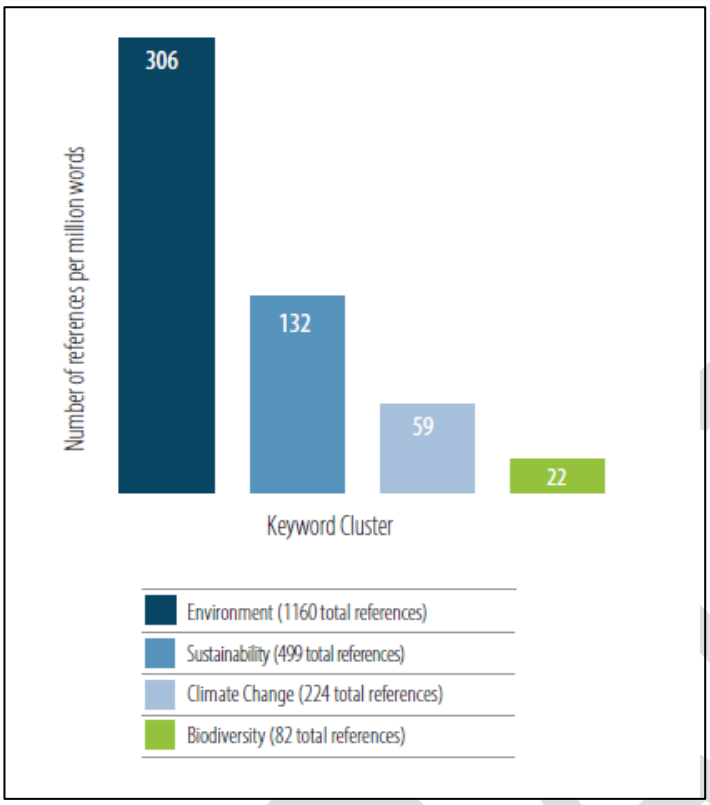
4.2.1.3. Summary of UNESCO (2021b) Survey Entitled "Learn for our planet. A global review of how environmental issues are integrated in education"

Another survey by UNESCO (2021b) examined the extent to which environmental issues are included in UNESCO Member states national curricula, using three data sources. The first data source involved systematic analysis of primary and secondary curricula education policy documents across 46 UNESCO Member states. A total of 37 education sector plans (ESPs) and 41 national curriculum frameworks (NCFs) were analysed for the presence of key words, including: *sustainability*, *environment*, *climate change* and *biodiversity*. The second data source involved interviews with 20 education stakeholders with expertise about environmental issues inclusion in their countries' educational policies. Finally, the third source included the analysis of online surveys retrieved from teachers and education leaders in primary, secondary and tertiary education, consisting of 1600 responses from 93 countries and territories.

The document analysis obtained from 46 states reaffirmed the findings in UNESCO (2021a), which also found that the term CC was mentioned at least once, in only 47% of the curricula, making more than half of the curricula and policy documents with no mentioning of CC at all. This in contrast to 83% of documents mentioning the term "environment" at least once, and 69% mentioning sustainability at least once. The depth of inclusion of environmental themes was on average very low. Furthermore, the survey found that environmental-related contents are most likely to be included in biology, science and geography, with very low implementation of the cross-curriculum inclusion approach. Figure 4.2.5 presents the number of references per million words of each of the four key terms.

Figure 4.2.5

Standardized number of references, by theme

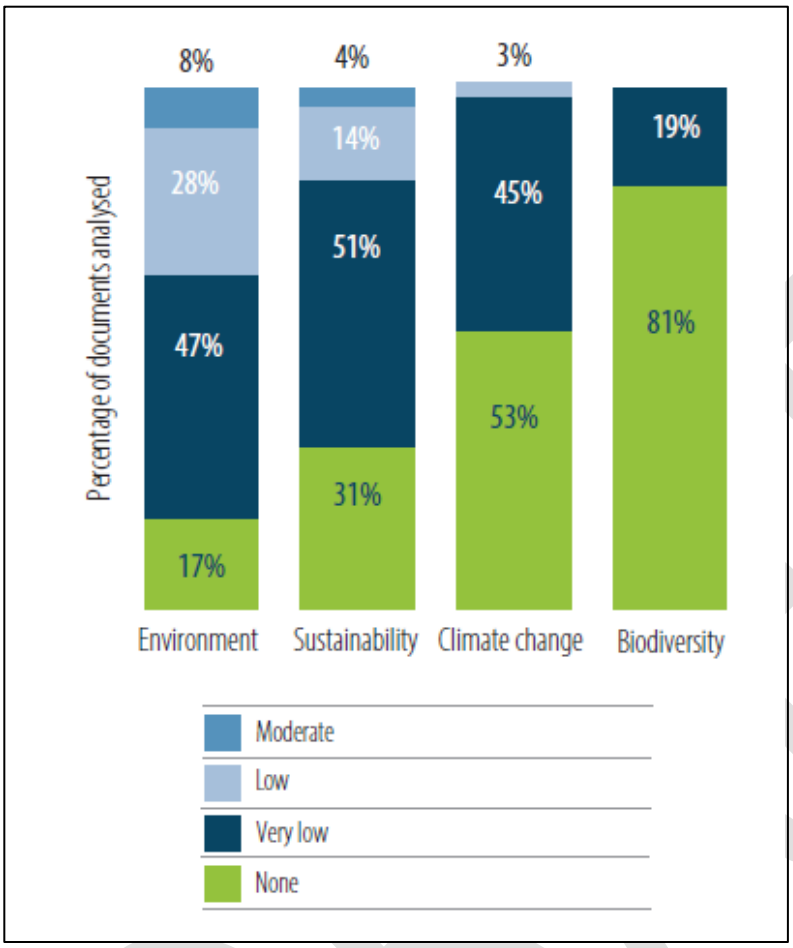


Note. Reprinted from "Learn for our planet. A global review of how environmental issues are integrated in education", by United Nations Educational, Scientific and Cultural Organization (UNESCO), 2021b, (https://unesdoc.unesco.org/ark:/48223/pf0000377362), p. 23. Copyright 2021 by UNESCO: Paris.

Figure 4.2.5 demonstrates the low level of mentioning of the key term CC. Further examination of the depth of focus in each of CC mentioning, reveals that in 53% of the times there is no depth at all, in 45% of the mentioning the depth was very low, and only 3% of mentioning received a grade of low depth. These findings are presented in Figure 4.2.6. The survey calls for more integration of ESD in national curricula.

Figure 4.2.6.

Relative levels of focus in documents, by theme



Note. Reprinted from "Learn for our planet. A global review of how environmental issues are integrated in education", by United Nations Educational, Scientific and Cultural Organization (UNESCO), 2021b, (https://unesdoc.unesco.org/ark:/48223/pf0000377362), p. 24. Copyright 2021 by UNESCO: Paris.

Interview data suggested that there is an imbalance between "cognitive learning", "socio-emotional learning" and "action-oriented learning", where there is a stronger emphasis on cognitive learning. As discussed elsewhere in this report, this distinction is not substantiated by any theoretical grounding and seems practically lacking distinguishable characteristics that may be clearly identified in terms of pedagogy and content knowledge implications.

Finally, the survey reveals insufficient teacher training, where 36% of countries do not include any environmental themes, let alone CC contents, in their in-service teacher training and pre-service teacher training.

4.2.1.4. Summary of Laessøe and Mochizuki (2015) Study Entitled "Recent trends in national policy on education for sustainable development and climate change education"

The study involved reviewing 17 national policies on CC education and ESD. The policy documents were obtained from: Canada/Manitoba, Brazil, Chile, Costa Rica, The Dominican Republic, Denmark, UK/England, South Africa, India, Bangladesh, China, South Korea, Vietnam, Indonesia, Philippines Tuvalu and Australia.

The review reveals that CC education is addressed in 15 of the 17 countries. However, these policies are often general and mainly intentional. Chile has two separate national policies, one for CC education and one for ESD. Bangladesh and Tuvalu on the other hand, developed only CC educational policy, with no accompanying ESD policies. Only Bangladesh, Philippines and Tuvalu had policies specifically addressing disaster risk reduction (DRR).

In most of the surveyed countries, CC education is subsumed under other things such as ESD, EE or Quality Education. In Costa Rica, Canada/Manitoba and the Dominican Republic, CC education is subsumed under their EE and ESD policies, with no specific dedicated policy. In South Africa, CC education is intended to be part of ESD, however this remains at the level of intent, with no evidence of application. In China CC education appears under Quality Education agenda. In Vietnam the Ministry of Education and Training promotes CC education as interlinked with ESD, however CC education is not embedded within ESD, but rather the two are conceived as complementary. In England, CC education policies focus on developing "green skills", without reference to ESD.

The study reveals that in some countries CC education policy development involves various forms of inter-sectorial collaborations. For example, in Vietnam, in March 2011 the Ministry of Education and Training, as part of its action plan development, organized a workshop on sharing experiences and strengthening collaboration on CC education. In Indonesia a planning workshop was setup in 2012 to discuss the development of a national strategy on CC education. This workshop involved diverse government departments, the private sector, education institutions, NGOs and UN organizations. Indonesia was also noted for its collaboration between the Ministry of Education and the Ministry of the Environment. In a previous study by UNESCO (2021a), it was noted that such inter-ministerial collaboration is important for advancing CC education policy.

Across the various countries "soft governance" seems to be the preferred strategy, where CC education does not receive an official status and there is limited direct governmental involvement in implementation. The authors note that across the analysed policies there is lack of elaboration on concrete action plans and curricular frameworks; lack of implementation mechanisms, and allocation of responsibilities; fragmentation across the board – between the policy and its

implementation, and between the various sub-national levels; lack of knowledge and engagement among key stakeholders; and lack of monitoring and evaluation of the practice. Overall, the authors note that while their study was able to identify and describe some governmental policy interventions to promote CC education, the existing efforts seemed too weak to ensure CC education implementation. The soft governmental instruments are too sporadic and marginal to have an effect. The authors reference Fien (2012) who identified six characteristics of good governance in the context of ESSD. These include: "(a) integrated structures of government; (b) policy integration; (c) vertical and horizontal coordination; (d) participation, consensus orientation and responsiveness; (e) conceptual coherency; and (f) accountability, effectiveness and efficiency" (Laessøe & Mochizuki, 2015, p. 40).

4.2.1.5. Summary of Dawson et al. (2022) Study Entitled "A cross-country comparison of climate change in middle school science and geography curricula"

This study compared the science and geography middle years curricula of six states for the presence of CC, using key words search. The selection of subjects was informed by previous studies suggesting the CC is primarily taught in science and geography (UNESCO, 2021b). Middle years levels were selected due to the fact that in most countries, science and geography are core subjects, only becoming elective in higher Year levels. The selection of countries was based on attempt to represent cultural and geographical diversity. The selected countries were: Australia, Canada/Ontario, Indonesia, England, Finland, and Israel.

The **Australian Curriculum** (Australian Curriculum Assessment and Reporting Authority [ACARA], 2021) was developed in 2012 and at the time of writing the paper, it was undergoing a review. The curriculum is organised by Learning Areas, where each Learning Area may be further divided into strands. For each Year level there are Content Descriptors, which outline what students need to learn, and there are also Elaborations, which provide examples of the types of content that could be learnt. Not all Elaborations must be taught. Additionally, sustainability appears as a Cross-Curriculum Priority. Meaning that teachers may implement aspects of sustainability in their respective Learning Areas. However, this is not a requirement, and there are no benchmarks or assessment standards.

The term CC appears once in Year 10 Earth and Space Science sub-strand on Global Systems. It appears as an Elaboration only, and not as Content Descriptor, as follows: "Investigating the effect of climate change on sea levels and biodiversity … and … examining the factors that drive the deep ocean currents, their role in regulating global climate … .' (ACSSU189). Further in Year 10, in the science strand Science as a Human Endeavour, CC appears under three elaborations, as follows: (1) "considering the role of science in identifying and explaining the causes of climate change"

(ACSHE191); (2) “considering how computer modelling has improved knowledge and predictability of phenomena such as climate change and atmospheric pollution” (ACSHE192); and (3) “considering the scientific knowledge used in discussions relating to climate change” (ACSHE194). In all these elaborations, CC appears as an example for teaching something else and not as a topic on its right. In other areas of the geography curriculum, issues directly related to CC are mentioned without using the term CC, thus “muddling the science” (National Center for Science Education and the Texas Freedom Network Education Fund, 2020, p. 6). This may be examplified in the following descriptor “‘human-induced environmental changes that challenge sustainability” (ACHGK070). Overall, it is unlikely that teachers following the Australian Curriculum will be addressing CC at any acceptable level.

In **Canada**, the Provincial **Ontario Curriculum** was introduced in 2007 and is divided into nine compulsory subjects including Science and Canadian and World Studies (where Geography is located). In addition, there are seven transferable skills that include global citizenship and sustainability. Students attend elementary school until year 8 and secondary school commences in year 9, hence the focus of the analysis on years 9 and 10. In Science, CC apears in Year 10 under Understanding Earth and Space Science: Climate Change (Academic) and Earth’s Dynamic Climate (Applied) (Ontario Curriculum Grades 9 and 10 Science, 2013). Across these two topics CC is explicitly mentioned 43 times. CC appears in the Learning outcomes of this unit, as follows: Global climate change is influenced by both natural and human factors; Climate change affects living things and natural systems in a variety of ways; people have the responsibility to assess their impact on climate change and to identify effective courses of action to reduce this impact (p. 78). This curriculum presents the errounous idea by which CC is caused by both human and non-human causes. The scientiofic concenzus is that CC is caused only by humans. Additionally, the curriculum suggests another somewhat problemtaic idea by which people’s individual actions have direct impact on CC, thus each person has a personal responsibiliyty to assess their behaviour and solve the CC problem through their individual behavior. Elsewhere in this report, I present multiple evidence for the factual incorrectness of this assumption.

The learning outcomes for the Earth’s Dynamic Climate include: “Analyse effects of human activity on climate change, and effects of climate change on living things and natural systems”; “Investigate various natural and human factors that have an impact on climate change and global warming”; and “Demonstrate an awareness of various natural and human factors that contribute to climate change and global warming” (p. 90).

In Geography, the term, climate, as linked to climate change is mentioned explicitly six times in the year 9 and 10 curriculum in sample questions to develop geographical skills.

In summary, the Science curriculum has a compulsory year 10 unit on climate change for both academic and applied streams, providing students with am opportunity to study CC in a focused and connected way.

The **English National Curriculum** was developed in 2014 and consists of year bands called Key Stages (KS). In secondary school, Key Stage 3 (age of 11–14) covers years 7-9 and Key Stage 4 (age of 14–16) covers years 10 and 11. The focus of this analysis is on Key Stage 3. There are 12 compulsory subjects, including Science at 3–4 h a week and Geography with 1–2 h a week (Department for Education [DfE], 2014). Climate change is explicitly mentioned in the national curriculum within the subject content of Chemistry under the topic 'Earth and atmospheric science' and Geography under the topic of 'Human and physical geography' (DfE, 2014). In Chemistry, CC appears under Earth and Atmosphere, addressing "…the production of carbon dioxide by human activity and the impact on climate' (DfE, 2014, p. 64). In Geography under Human and Physical Geography, the curriculum discusses "… how human and physical processes interact to influence, and change landscapes, environments and the climate; and how human activity relies on effective functioning of natural systems' (DfE, 2014, p. 92).

In summary, in England National curriculum, CC appears minimally in years 7–9, and not at a suifficient level to ensure comprehensive understanding by students who study according to the curriculum.

The **Finland National Core-Curriculum** was developed in 2014 (Finnish National Agency for Education, 2014). Science is taught in middle school (years 7–9) as descrete sibjects, including: Physics, Chemistry, Biology and Geography (each taught 1–2 h a week, equalling 3.5 h a week in total) and Health Science (1 h a week). All schools in Finland follow the national core-curriculum, which municipalities and schools use as a foundation to build their own, more specified curriculum. The Finnish National core-curriculum is value-based. The 500-page curriculum document consists of values, objectives and general principles that number around 100 pages. The rest of the document covers the subject syllabi (Lähdemäki, 2019).

One of the core values is to direct students towards a sustainable future. As climate change is a key barrier to a sustainable future, in essence, climate change education should be addressed in all school subjects. That said, CC is explicitly mentioned once in the general section of the curriculum. In biology, CC apears in relation to habitats of animals (BI-T3). In Geography, CC apears as a cross-

cutting theme, alongside other environmental themes, such as lifecycle assessment. It appears in relation to topics such as limited natural resources (GE-T4) and appreciation of the nature and biodiversity (GE-T11). In both biology and geography, CC is also connected to participatory action (L7) (Finnish National Agency for Education, 2014). In summary, across the 500-page curriculum, CC is explicitly mentioned only four times (Lähdemäki, 2019).

The Indonesian Curriculum for middle school was developed in 2013 and consists of eight core subjects, including Natural Science and Social Studies (Ministry of Education and Culture, 2014). Natural science (also known as IPA Terpadu) is offered 5 h a week in middle school, comprised of 33 competencies. "Understanding the cause and effect of climate change" appears in Year 7 as one of the 33 competencies. Year 7 further includes a dedicated CC unit, taught for one term over 7–15 lesson-hours. The two competencies associated with this unit include: (1) Basic competence for knowledge dimension: analysing climate change and its impact to the environment; and (2) Basic competence for skills dimension: writing a paper about climate change adaptation and mitigation (Ministry of Education and Culture, 2018). CC contents include: Defining the greenhouse effect; the causes of the greenhouse effect; the mechanisms of the greenhouse effect; defining global warming; causes of global warming; the effects of gloibal warming; human contributions to global warming (Ministry of Education and Culture, 2020). The curriculum further specifies specific strategies for skill aquisitrion, including students: (1) collecting CC data; (2) analysing CC causes and effects on ecosystems; (3) develop oral and written suggestions for addressing CC.

Social science includes sociology, history, geography and economy, and is taught for 4 h a week. CC is not mentioned throughout the Social Studies curriculum. In summary, the Insonesian Curriculum for middle years, takes a similar approach to the Ontario curriculum by dedication a unit to CC, ensuring a comprehensive approach for addressing CC.

The **Israel National Curriculum** for the middle years was developed in 2016, including Science and Technology (six hours per week) and Geography (two hours per week) as core subjects (Knesset, Centre for Research and Information, 2010, 2015). The curriculum documents are comprehensive, organized into six strands of: (1) Administrative details; (2) Main topics; (3) Content knowledge, (4) Competencies such as interpersonal skills; (5) Values; and (6) Materials for teaching, learning and assessment. In Science and Technology, environmental literacy is an overarching theme, embedded within the curriculum from its conceptualisation through to the content specifications. CC is conceived as a topic of environmental literacy. Across Strands 1–5, references to CC appear four times. In Strand 6 (Materials for teaching, learning and assessment), references to CC are prevelant

and there is an extensive list of resources across all Middle Years levels (Government of Israel Ministry of Education, Sciences Branch, n.d.).

In the Geography curriculum, sustainable development is concieved as the organizing theme and a guiding value, with CC being conceptuialized as a topic of sustainable development. This perception is examplified in the following statement of the overarching goals: 'Understanding and acknowledging the role of humans in modifying the landscape and protecting the environment' (p. 2); and in the value goal: 'Cultivation of values of respect for nature and the landscape, and enhancing awareness of the value of sustainability' (p.3) (Government of Israel, Ministry of Education, Portal for Education Workers/Pedagogical Space, n.d.). In comparison to the other analyzed geography curricula, CC is addressed extensively, as follows: 10 times (six of which are in core topics) in the content specifications; 7 of 34 digitised activities in year 7 relate to CC; and CC appears 79 times in the assessment kits. In summary, both climate change and global warming appear extensively throughout the whole of middle years in both Geography (predominantly) and Science and Technology. This is facilitated, in part, by the overarching themes of sustainable development and environmental literacy, respectively. The inclusion of climate change in some digital resources and multiple assessment items may assist teachers to explicitly address climate change.

In summary, across the seven curricula, the findings reveal that the most prominent approach for CC inclusion is the cross curricular approach. Indonesia and Ontario stand out in addressing CC as a topic on its own right. In all other curricula, CC is subsumed under other topics, or just mentioned as an example for something else. In Canada CC is addressed as a topic in Year 10, whereas in Indonesia the CC topic appears in Year 7. The authors suggest that the decision to dedicate a CC topic at an older age and later learning stage provides more time for students to mature cognitively and acquire the necessary science and social studies basis for understanding the complex relationships within CC systems. In six of the seven states (With the exception of Israel) CC appears primarily in Science. In Israel Geography takes the lead by addressing CC extensively as a topic of sustainability. In Australia, England and Finland, CC is barely mentioned in the curriculum. Overall the examination of the six curricula suggests limited conceptualisation of the scope of CC, relying mostly on a fragmented approach, where parts of CC are addressed under different topics in an incomplete way.

4.2.2. Climate Change Curricula in the United States of America (USA)

In the USA, each state retains its own constitutional authority to develop educational policies. Across the USA it has been reported that science education forms the predominant subject through which CC is incorporated in the curricula (Drewes et al., 2018). The Next Generation Science Standards

(NGSS; NGSS Lead States, 2013) forms the main curriculum framework for teaching science and engineering in the USA. The NGSS was developed on the basis of the National Research Council's Framework for K–12 Science Education (National Research Council [NRC], 2012), by a consortium of states and organisations working with the NRC, the National Science Teaching Association, the American Association for the Advancement of Science, and the educational organization Achieve (National Center for Science Education and the Texas Freedom Network Education Fund, 2020). By 2020, it was reported that 20 states have adopted the NGSS as their science and engineering curriculum, accounting for 36% of public-school student population. An additional 24 states, accounting for 35% of public-school student population, have developed their own standards guided by the NGSS. The remaining six states developed their own science standards (National Center for Science Education and the Texas Freedom Network Education Fund, 2020).

A survey conducted by the National Center for Science Education and the Texas Freedom Network Education Fund (2020) evaluated the presence of CC in the science curricula of the 50 states. Three CC expert reviewers assessed the standards by answering six focus questions and assigning a numerical score. The findings revealed that only 27 states earned a score of B+ or above for their CC representation in the science curricula. Of these 27 states, 20 states and DC, have adopted the NGSS. Another 20 states received scores that are C+ or below. Out of which 10 states received D. The authors note that these states, are among the most populous in the country, such as Texas (F), Florida (D), Pennsylvania (F), and Ohio (D). Six states received a Fail grade. The NGSS itself earned the grade B+. Four states that based their science curriculum on the NRC framework, but not on the NGSS receives an A-, and another state that did the same received an A. Importantly, the reviewers expressed concerns regarding all the reviewed standards including the NGSS. Therefore, the authors caution that even states that received Grades A and A- require improvements in their CC education. Table 4.2.1 presents the results of the 50 states by their category (NGSS state, NRC Framework state, and non-NRC Framework state). Note that all the states that implement the NGSS received an overall grade of B+, which is the NGSS grade.

Table 4.2.1.

Climate change education in science curricula across the 50 USA states: Overall grade for NGSS states, NRC Framework states, and non-NRC Framework states

State	Overall Grade	State	Overall Grade	State	Overall Grade
Alabama	F	Kentucky	B+	North Dakota	A-
Alaska	A-	Louisiana	B	Ohio	D
Arizona	C	Maine	B+	Oklahoma	B-
Arkansas	B+	Maryland	B+	Oregon	B+
California	B+	Massachusetts	B+	Pennsylvania	F
Colorado	A-	Michigan	B+	Rhode Island	B+
Connecticut	B+	Minnesota	B-	South Carolina	F
Delaware	B+	Mississippi	C	South Dakota	C-
DC	B+	Missouri	C-	Tennessee	B-
Florida	D	Montana	C	Texas	F
Georgia	F	Nebraska	C+	Utah	C+
Hawaii	B+	Nevada	B+	Vermont	B+
Idaho	C+	New Hampshire	B+	Virginia	F
Illinois	B+	New Jersey	B+	Washington	B+
Indiana	D	New Mexico	B+	West Virginia	D
Iowa	B+	New York	A-	Wisconsin	C-
Kansas	B+	North Carolina	C-	Wyoming	A

Note. Adapted from "Making the Grade? How State Public School Science Standards Address Climate Change" by *National Center for Science Education and the Texas Freedom Network Education Fund*, 2020. Copyright 2020 by National Center for Science Education and the Texas Freedom Network.

NGSS state NRC Framework state Non-NRC Framework state

The reviewers commented on a set of reoccurring problems in the treatment of CC within the science curricula. The first problem was promoting false debate. The state of Virginia for example required students to debate the existence of CC. The reviewers noted that

> there is not debate among climate scientists about the reality of human-caused climate change. Debating in K–12 science standards is a classic device employed by deniers (of evolution or climate change) to get their positions presented in public schools absent any (non-cherry-picked) data. Tellingly, this is the only place in West Virginia standards that employs debate" (National Center for Science Education and the Texas Freedom Network Education Fund, 2020, p. 5).

The reviewers further noted that not only curricula should not give in to such misrepresentation of science facts, curricula should also highlight and expose attempts to manipulate and misrepresent

data. Another critique by the reviewers was the avoidance of some curricula to clearly name "climate change" when addressing CC issues. Meaning, some CC issues are addressed without explicitly naming these issues as such. Further critique relates to "muddling the science", by using ambiguous wording, suggesting unclear evidence. For example ""Utah's standards [which received a C+] have been masterfully edited or otherwise changed to downplay if not ignore the reality, human cause, and seriousness of climate change." (*ibid*, 2020, p. 6). The reviewers also expressed critique that some curricula failed to inspire hope. Here I present my reservation from this critique, as hope may easily turn to false hope, that may further lead to depression or apathy. Elsewhere I address the role of hope in CC education. Here, it is sufficed to state that there is currently insufficient evidence-based research related to the role of hope in CC pedagogy, and that the authors could do well by refraining from advocating unsubstantiated instructional methods.

4.2.2.1. Analysis of Climate Change in the Next Generation Science Standards (NGSS)

In what follows, I first present an overview of the NGSS. This is followed by critically examining the epistemological conceptualization of CC within the NGSS framework. I than analyse CC presence in the three year bands of: Primary, Middle and High School. Finally, I conclude by summarising the main strengths and weaknesses of CC education in the NGSS curriculum.

The NGSS consists of three interconnected dimensions of learning, including: disciplinary core ideas; science and engineering practices; and crosscutting concepts. The performance standards reflect the integration of the three dimensions, specifying the knowledge and skills that students need to be able to demonstrate at a given grade level or across a grade band (Harris et al., 2022).

Climate change is incorporated in the NGSS as a recommended concept within the disciplinary core ideas and in most of the crosscutting concepts. However, the topic of climate change appears explicitly only in Earth and Space Science in one standard in middle school and four standards in high-school. Foundational climate-related ideas such as the carbon cycle appear at every level from K-12, across the four disciplinary core ideas (DeWaters et al., 2014; Drewes et al., 2018; NGSS Lead States, 2013).

In Earth and Space Science Disciplinary Core Idea, CC appears subsumed under the sub-Disciplinary Core Idea entitled ESS3: Earth and Human Activity. This sub- Disciplinary Core Idea consists of four themes, as follows: ESS3.A: Natural Resources; ESS3.B: Natural Hazards; ESS3.C: Human Impacts on Earth Systems; and ESS3.D: Global Climate Change (NGSS Lead States, 2013). Table 4.2.2. presents the NGSS Disciplinary Core Ideas and sub- Disciplinary Core Ideas.

Table 4.2.2.

Next Generation Science Standards (NGSS) Disciplinary Core Ideas (DCIs) and sub-ideas.

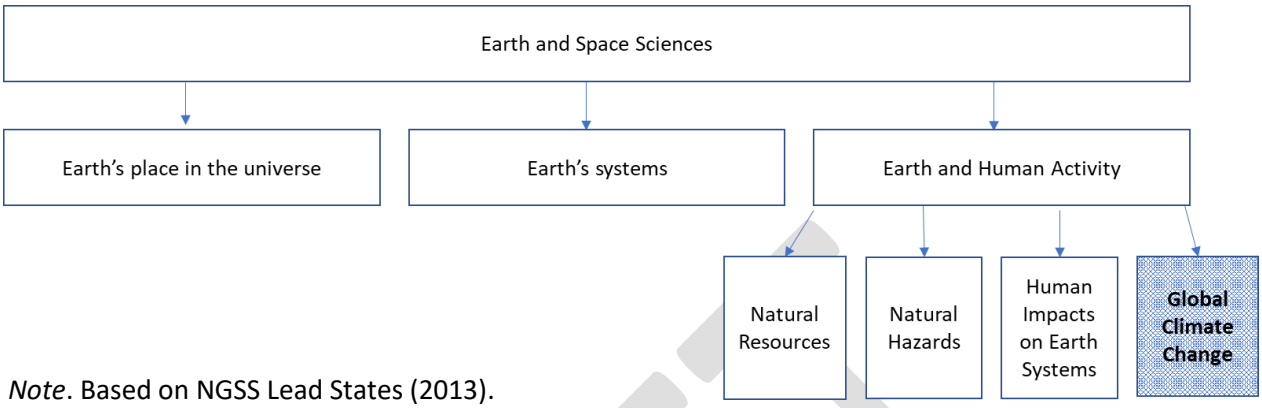
Note. Adapted from NGSS Lead States (2013).

Physical Science	Life Science	Earth and Space Science
PS1 Matter and Its Interactions PS1A Structure and Properties of matter PS1B Chemical Reactions PS1C Nuclear Processes **PS2 Motion and Stability: Forces and Interactions** PS2A Forces and Motion PS2B Types of Interactions PS2C Stability and Instability in Physical Systems **PS3 Energy** PS3A Definitions of Energy PS3B Conservation of Energy and Energy Transfer PS3C Relationship Between Energy and Forces PS3D Energy and Chemical Processes in Everyday Life PS4 Waves and Their Applications in Technologies for Information Transfer **PS4 Waves and Their Applications in Technologies for Information Transfer** PS4A Wave Properties PS4B Electromagnetic Radiation PS4C Information Technologies and Instrumentation	**LS1 From Molecules to Organisms: Structures and Processes** LS1A Structure and Function LS1B Growth and Development of Organisms LS1C Organization for Matter and Energy Flow in Organisms LS1D Information Processing **LS2 Ecosystems: Interactions, Energy, and Dynamics** LS2A Interdependent Relationships in Ecosystems LS2B Cycles of Matter and Energy Transfer in Ecosystems LS2C Ecosystem Dynamics, Functioning, and Resilience LS2D Social Interactions and Group Behavior **LS3 Heredity: Inheritance and Variation of Traits** LS3A Inheritance of Traits LS3B Variation of Traits **LS4 Biological Evolution: Unity and Diversity** LS4A Evidence of Common Ancestry LS4B Natural Selection LS4C Adaptation LS4D Biodiversity and Humans	**ESS1 Earth's Place in the Universe** ESS1A The Universe and Its Stars ESS1B Earth and the Solar System ESS1C The History of Planet Earth **ESS2 Earth's Systems** ESS2A Earth Materials and Systems ESS2B Plate Tectonics and Large-Scale System Interactions ESS2C The Roles of Water in Earth's Surface Processes ESS2D Weather and Climate ESS2E Biogeology **ESS3 Earth and Human Activity** ESS3A Natural Resources ESS3B Natural Hazards ESS3C Human Impacts on Earth Systems ESS3D Global Climate Change

A review of CC positioning among the disciplinary core ideas, suggests that epistemologically, CC forms an idea within the broader idea of Earth and Human Activity, which is further subsumed under Earth and Space Science, and further subsumed under Science. Figure 4.2.7 illustrates these conceptual relationships. This conceptualisation of the relationships is evidently incorrect, as CC is not a mere concept, or an item separated from ESS3C Human Impact on Earth Systems, but rather a broad field of knowledge consisting of multiple concepts and the relationships between them, as evidenced by examining the various IPCC reports (IPCC, n.d.). Furthermore, CC is clearly not a sub-sub-disciplinary core idea of science, as the scope of CC is broader than science, not narrower than science, including various other fields such as economy, sociology, philosophy and more.

Figure 4.2.7.

NGSS Conceptualizing CC as an idea within science core ideas



Note. Based on NGSS Lead States (2013).

In the process of developing the NRC framework into the NGSS curricular standards, the sub Disciplinary Core Ideas were regrouped into new categories, which the NGSS identifies as "Topics". Within each Topic, the Performance Expectations; Science and Engineering Practices; Disciplinary Core Ideas; and Crosscutting Concepts –all correspond with the NRC framework (NRC, 2012). However, in the new Topic organization, the sub-disciplinary core idea Global Climate Change is not included. Instead, its affiliated content item are spread across Earth and Space Sciences, and appear mainly across the three topics of: Earth's Systems; Weather and Climate; and Human Sustainability. Table 4.2.3 presents the Disciplinary Core Ideas and their Topics in high school only. The Topics in Primary and middle school, are different and are not presented in this exemplar. When it comes to CC, this new arrangement seems even more peculiar than the original, as it positions human sustainability as a standalone topic that may be addressed as an independent system within Earth systems. In turn, CC loses its epistemological position as one of the sub-ideas altogether.

Table 4.2.3.

Disciplinary Core Ideas and their Topic, in the NGSS, by elementary, middle and high school levels.

Physical Sciences	Life Sciences	Earth and Space Sciences
Structure and Properties of Matter	Structure and Function	Space Systems
Chemical Reactions	Matter and Energy in	History of Earth
Forces and Interactions	Organisms and Ecosystems	Earth's Systems
Energy	Interdependent Relationships in Ecosystems	Weather and Climate
Waves and Electromagnetic Radiation	Inheritance and Variation of Traits	Human Sustainability
	Natural Selection and Evolution	

Examination of the rationales explaining the two Topics of Weather and Climate and Human Sustainability, reveals further reductionist approach in CC conceptualization. In Weather and Climate the rational explains:

> The performance expectations in HS.Weather and Climate help students formulate an answer to the question: "What regulates weather and climate?" Four sub-ideas from the NRC Framework are addressed in these performance expectations: ESS1.B, ESS2.A, ESS2.D, and ESS3.D. Students understand the system interactions that control weather and climate, **with a major emphasis on the mechanisms and implications of climate change**. Students can understand the analysis and interpretation of different kinds of geoscience data allow students to construct explanations for the many factors that drive climate change over a wide range of time scales. The crosscutting concepts of cause and effect and stability and change are called out as organizing concepts for these disciplinary core ideas. In the HS.Weather and Climate performance expectations, students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data; and to use these practices to demonstrate understanding of the core ideas. (NGSS Lead States, 2013, P. 90)

This framing suggests that CC is conceptualised primarily as a science problem, where the aim is to unpack its underlying mechanisms and their effects. In the Topic Human Sustainability, the term CC is conspicuous in its absence from the rationale. Instead, the Topic is explained as follows:

> The performance expectations in HS.Human Sustainability help students formulate answers to the questions: "How do humans depend on Earth's resources?" and "How do people model and predict the effects of human activities on Earth's climate?" Six sub ideas from the NRC Framework are addressed in these performance expectations: ESS2.D, ESS3.A, ESS3.B, ESS3.C, ESS3.D, and ETS1.B. Students understand the complex and significant interdependencies between humans and the rest of Earth's systems through the impacts of natural hazards, our dependencies on natural resources, and the environmental impacts of human activities. The crosscutting concepts of cause and effect; systems and system

> models; stability and change; and influence of engineering, technology and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas (NGSS Lead States, 2013, pp. 90-91).

Overall, the rationale portrays a narrow conceptualisation of CC, as well as an epistemological inconsistency, when transitioning from the NRC framework to the NGSS. This inconsistency also appears across the curriculum, when at times CC appears as an idea demonstrating other ideas, and at times as a more comprehensive body of knowledge. However, at none of CC appearances, the field is properly defined, scoped and represented. This inconsistency and lack of clarity is reflected in the use of terms.

Beginning with the sub Disciplinary Core Idea "Global Climate Change", the term Global Climate Change suggests that there may be an alternative term, which is Local, or Regional CC. In other words, there may be two types of CC – global and local. The fact is that CC is a global phenomenon. While local and regional drivers, processes and impacts may differ, CC is still essentially global, and there are no two Climate Change (i.e. Global Climate Change and Regional Climate Change). This basic fact may become misunderstood, through the addition of the unnecessary signifier "global". Throughout the curriculum, CC terminology continues to appear inconsistent. For example: "climate changes" (MS-ESS3-5), "long-term climate change" (HS-LS4-4), "changes in climate" (HS-ESS2-4), "changes to global and regional climate" (HS-ESS2-4), "…affect climate" (HS-ESS2-4), "global climate models" (ESS2.D). Together, these diverse terms signify that CC is not conceived as a coherent body of knowledge to which there is a designated term. This is a conceptual problem no less than referring to the noun "biology", by using a verb such as "biologes" (as analogous to "climate changes"); or disregarding the designated term "biology", by referring to it by another noun such as "global bio models" (as analogous to "global climate models"). Furthermore, the term "long term climate change", is misleading as it suggests that there may be "short term climate change". This issue is further elaborated when discussing the incorrect use of the term in the High School curriculum, in relation to Performance Expectation: HS-LS4-4. In what follows CC presence in the NGSS is analysed by grade bands, Primary, Middle and High school, followed by a summary of the NGSS strengths and weaknesses in relation to addressing CC.

Analysis of climate change in the NGSS by year band

Primary school. CC does not appear as a topic (or even a term) prior to Middle School. Furthermore, the curriculum **specifically instructs not to include CC in primary schools**, in two Expectation Performances, as follows:

In Year 3, Expectation Performance 3-LS4-4 specifically excludes CC as follows:

> Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.* [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [Assessment Boundary: Assessment is limited to a single environmental change. Assessment **does not include the greenhouse effect or climate change**.] (NGSS Lead States, 2013, 3-LS4-4)

A similar specific exclusion appear under Weather and Climate Performance Expectation, as follows:

> Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. **Assessment does not include climate change**.] (*ibid*, 2013, 3-ESS2-1).

While CC is not addressed specifically in primary school, the curriculum does begin developing foundational CC science knowledge from as early as Kindergarten. This foundational knowledge is systematically developed across the primary year levels under the following topics: Kindergarten and Year 3: Weather and Climate; Year 2, 4 and 5: Earth Systems. Further foundational CC knowledge may be associated with the Kindergarten, Year 2 and Year 3 topic: Interdependent Relationships in Ecosystems.

In my view, the decision not to include CC in the early years is age-appropriate. While NGSS does not explicitly justify this decision, it aligns well with my view by which CC is an inappropriate topic for teaching in the early years, due to its high level of complexity and potential threat to students' well-being. The Primary NGSS curriculum also reflects the understanding that CC needs to be methodologically constructed across year levels, starting from foundational science knowledge and culminating in multidisciplinary complex concepts; and that this knowledge construction needs to be carried out in an organized and age-appropriate manner.

Unlike the exclusion of CC from the early years, natural hazards are addressed in the Performance Expectations as early as in Year 3, as follows: "Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.* [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]" ((*ibid*, 2013, 3-ESS3-1). Critical analysis of the inclusion of natural hazards in the NGSS and its relation to CC is discussed elsewhere, in the context of analysing New Jersey Curriculum.

Middle School. In Middle School, CC appears under the Disciplinary Core Idea Earth and Space Sciences. While critical foundational knowledge is addressed across the various disciplinary core ideas, CC is specifically addressed, as follows:

Topic: Weather and Climate, sub-Disciplinary Core Idea: ESS3.D: Global Climate Change

> Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (**global warming**). Reducing the level of **climate change** and reducing human vulnerability to whatever **climate changes** do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

Here the level of complexity seems age-appropriate, where the curriculum introduces a basic CC concept, stating that human activities of releasing greenhouse gases causes a rise in Earth's mean surface temperature. The Disciplinary Core Idea provides some further elaboration of the concepts related to mitigation and adaptation. The ideas presented at this stage are not overly complicated, retaining a level of organization essential for comprehension, while focusing on the science aspects of CC, and framing it mostly as a scientific technological problem, but also as a problem of human behaviour. This approach may be successful in constructing essential science concepts related to CC, while avoiding overload, which may obstruct learning.

High School. The complexity of the underlying CC science continues to increase in High School curriculum. As mentioned above, the Disciplinary Core Idea Earth and Space Sciences does not include Global Climate Change as a sub–Disciplinary Core Idea. Instead, the most closely relevant Topics are Weather and Climate and Human Sustainability. However, aspects related to CC can also be found in other Disciplinary Core Ideas, across the High School NGSS curriculum. Some exemplars are as follows:

Topic: Interdependent Relationships in Ecosystems; Sub Disciplinary Core Idea LS2.C: Ecosystem Dynamics, Functioning, and Resilience: "Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and **climate change**—can disrupt an ecosystem and threaten the survival of some species". (HS-LS2-7). Here CC appears as one example among others, examplifying a cause of ecosystems disruptions.

Sub Disciplinary Core Idea LS4.D: Biodiversity and Humans:

> Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive

> species, and **climate change**. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7), (HS-LS4-6)

Here once again CC appears as an exemplar for demonstrating something else. In this case it demonstrates disruptive human activities that negatively impact biodiversity.

Topic: Natural Selection and Evolution; Performance Expectation: HS-LS4-4:

> Construct an explanation based on evidence for how natural selection leads to adaptation of populations. [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, **long-term climate change**, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.] (HS-LS4-4).

This Performance Expectation does not address CC. However, it uses the term CC to address natural climate variability. The use of the term "long-term climate change" is confusing for two reasons. First, it is in misalignment with Performance Expectation HS-ESS2-4, where "**long term** changes in atmospheric composition" are defined as "10-100s of millions of years" (HS-ESS2-4). This timescale is evidently inappropriate for addressing issues related to natural selection as referred to in Performance Expectation: HS-LS4-4 above. Secondly, the term Performance Expectation: HS-LS4-4 suggests a potential misconception by which there might be two types of CC: "long term" and "short term". It may also inadvertently lead to the erroneous conclusion that what we are experiencing now is a "short term" CC as opposed to "long term" CC in past geological periods.

In High School, most of the concepts related to CC are addressed under the Core Idea Earth's Systems. Some of the sub-Disciplinary Core Ideas and the Performance Expectation do not directly mention CC, however the contents directly address CC. In what follows I present some critical CC concepts addressed in the curriculum, some of which do not specifically use the term CC, but may be required as foundational knowledge for understanding CC.

Performance Expectation HS-ESS2-2:

> Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. [Clarification Statement: Examples should include **climate feedbacks**, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion;

how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.] (HS-ESS2-2)

Sub Disciplinary Core Idea ESS2.D: Weather and Climate: "The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space". (HS-ESS2-2); "Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate". (HS-ESS2-6)

Topic: Weather and Climate; Performance Expectation HS-ESS2-4:

Use a model to describe how variations in the flow of energy into and out of Earth's systems result in **changes in climate**. [Clarification Statement: Examples of the causes of **climate change** differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of **changes in climate** is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.] (HS-ESS2-4)

Topic: Weather and Climate; Performance Expectation HS-ESS3-5:

Analyze geoscience data and the results from **global climate models** to make an evidence-based forecast of the current rate of global or regional **climate change** and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for **climate changes** (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a **climate change** and its associated impacts.]

Sub Disciplinary Core Idea ESS1.B: Earth and the Solar System

Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual **climate changes**. (secondary to HS-ESS2-4)

Sub Disciplinary Core Idea ESS2.A: Earth Materials and Systems

The geological record shows that **changes to global and regional climate** can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

Sub Disciplinary Core Idea ESS2.D: Weather and Climate: “The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space” (HS-ESS2-4); “Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus **affect climate**”. (HS-ESS2-4)

Sub Disciplinary Core Idea ESS3.D: Global Climate Change: “Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts”. (HS-ESS3-5)

Topic: Human Sustainability; Performance Expectation HS-ESS3-1.

> Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and **changes in climate** have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of **changes in climate** that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

Sub Disciplinary Core Idea ESS2.D: Weather and Climate:

> Current models predict that, although future regional **climate changes** will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by **global climate models** strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere (ESS2.D).

Sub Disciplinary Core Idea ESS3.A: Natural Resources: “All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors”. (HS-ESS3-2)

Sub Disciplinary Core Idea ESS3.B: Natural Hazards: “Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations”. (HS-ESS3-1)

Sub Disciplinary Core Idea ESS3.C: Human Impacts on Earth Systems: “The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources”. (HS-ESS3-3); “Scientists and engineers can make major contributions by developing

technologies that produce less pollution and waste and that preclude ecosystem degradation" (HS-ESS3-4).

Sub Disciplinary Core Idea ESS3.D: **Global Climate Change**: "Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities" (HS-ESS3-6).

Sub Disciplinary Core Idea ETS1.B. Developing Possible Solutions: "When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts". (secondary to HS-ESS3-2).

Overall, the review of NGSS, suggests that this curriculum takes CC a step forward by formally including it in the curriculum, with particular focus on the science aspects of CC. Johnson and Anderson (2017) highlight as strengths the aspects of addressing: CC mechanisms; analyzing large-scale data, developing arguments from evidence, characterizing uncertainty, making predictions about the future, and linking Earth's physical and biological processes at multiple scales.

Alongside these strengths, the present analysis reveals lack of epistemological clarity, coherency and consistency. There is acute lack in clear scoping of CC as a body of knowledge, which often leads to conceptual flaws, such as the ones demonstrated above and in Figure 4.2.1. Additionally, Johnson & Anderson (2017) conclude that this CC curriculum is

> not enough to prepare students for civic engagement around climate change. Students must also recognize the limits of science and appreciate that value judgments and political and economic concerns are also important aspects of the discourse around climate change. Unfortunately the social context … receives little attention in the NGSS (Johnson & Anderson, 2017, p. 117)

Furthermore, they conclude that "Because they ignore issues of how climate change affects human societies and environmental justice, the NGSS Performance Expectations fall short of describing the knowledge and practices students will need to be ethical and effective decisionmakers about climate-change-related issues" (*ibid*, 2017, p. 118). Additionally, the National Center for Science Education and the Texas Freedom Network Education Fund (2020) while commending the NGSS for addressing human responsibility for causing CC, they critique the curriculum for its ambiguity by framing human activity as a "major factor" rather than the only factor.

In my view, a critical question must be raised, as to whether the science curriculum can and should accommodate CC education in the first place, or whether CC requires a curriculum of its own, in which science is included as one of the sub-themes of CC. I believe that this question is the "elephant in the room", forming the main obstacle for any development of quality CC curriculum.

4.2.2.2. New Jersey Climate Change Curriculum Analysis

In June 2020, the State Board of Education adopted the 2020 New Jersey Student Learning Standards, making New Jersey the first state in the USA to incorporate K-12 climate change (CC) education across content areas (New Jersey Climate Change Education Hub, n.d.). The enactment of the new standards began in September 2022. In facilitating this enactment, a report entitled "Report on K-12 Climate Change Education Needs in New Jersey" (Madden, 2022), identified the following six goals for New Jersey's CC education:

> (1) Ensure that all New Jersey public school teachers are prepared to fully integrate climate change education across grade levels and content areas within five years of adoption of the 2020 New Jersey Student Learning Standards. (2) Educate all members of school communities, including families, students, teachers, school staff, administrators, school board members and community partners on scientifically accurate information regarding climate change to ensure that schools are designed to foster a sustainable future and economic prosperity. (3) Encourage community-focused collaboration among stakeholders including board members, students, families and teachers, facilities professionals and administrators to ensure that schools develop a comprehensive approach to climate change education. (4) Use an equity-focused approach to ensure that the neediest schools and districts receive the necessary financial and logistical support for climate change education implementation. Further, the disproportionate effects of climate change seen by communities of color, immigrant communities and low-income communities must be highlighted. (5) Center climate change education and experiences on what is happening locally. Place-based approaches to education that emphasize the New Jersey specific effects of climate change, and the local actions that impact global trends are more likely to make a lasting impact with students and motivate communities to commit to solution-building. (6) Provide multiple entry points to allow for school- and teacher-autonomy in deciding how to integrate climate change content within each unique learning context (Madden, 2022, p. 3).

The report puts forward the following enactment recommendations:

> (1) All K-12 public school educators, school staff and school board members must be introduced to the climate change standards at the various grade levels and content areas. (2) All K-12 public school teachers should be provided with the developmentally appropriate and content-specific explanations of climate change and its effects. (3) All K-12 public school teachers should have access to high-quality curricular materials beginning in September 2022 (Madden, 2022, p. 9).

The report further recommends that New Jersey public schools employ teacher leaders and district level curriculum supervisors to support teachers planning. It suggests allocating at least four planning meetings for grade level teachers or content area teachers, as appropriate. Other recommendations include allocating micro-credentials for teachers who complete their CC professional learning. To facilitate the process, the New Jersey Department of Education has developed a comprehensive

website to assist school districts in planning for the implementation of CC education. Finally, the report presents sets of recommendations related to: professional learning (PL) (elsewhere referred to as “professional development” (PD)); CC resources; community-based CC Education; and, support from Boards of Education. These sets of recommendations are summarised in what follows.

Recommendations related to PL include:

- Five-year funding of PL.
- Funding should be distributed by needs, favouring schools with more needs.
- Funding should not be on a competitive basis. All schools should receive funding.
- Schools should be autonomous to select the type of PL that best fits their needs.
- PL should use research-base frameworks.
- PL needs to include adult level content knowledge, experiential active learning and reflections.
- PL needs to include opportunities for collaborations and mentorship.
- PL should model effective classroom practices and highlight CC disproportionate effects on vulnerable communities.
- Teachers should have a say in the modality of their PLs. (Madden, 2022, p. 11).

Recommendations related to CC resources include:

- The New Jersey Department of Education and leading government organizations should provide a wide range of resources and develop a compendium of resources as the “go to” space.
- Provide fundings for schools to purchase curriculum resources, with prioritization to experiential learning in ecosystems and in the built environment.
- Course offerings should be aligned with grade levels and content areas. Districts should offer experiential coursework related to green collar professions.
- Curricular resources should be selected using research-based frameworks.
- Multiple entry points must be available for teachers when selecting climate change curricula. Teachers should have opportunities to refine and modify curricular selections over time.
- Curricular resources should be easily searchable, retrievable, and developed by educational professionals.
- Non traditional curricular resources should be valued alongside standard lessons and units.
- Resources should include a variety of structures from scripted to open-ended. Curricular resources should include opportunities for differentiation and inclusion.
- Curricular resources should include relevant and fact-based information regarding the disproportionate effects of climate change on vulnerable communities and emerging career paths for students to pursue. (Madden, 2022, p. 12).

Recommendations related to community-based CC education include:

- Climate education initiatives should connect global issues with those in local communities.
- Place-based approaches with local and regional examples should be prioritized in all curricular and professional learning efforts.

- School districts should have flexibility concerning how they choose to implement CC education initiatives with regard to PL and curriculum. This autonomy and adaptability will allow all schools to forge a path that is suitable for their own well-defined needs.
- Explicit attention should be paid to foundational experiences in preschool learning environments and offerings in higher education to ensure that extends beyond the K-12 arena.
- Project-based and solution-focused explorations should be centered on local and state-specific CC issues and their effects on ecological systems.
- Career and technical education schools should implement new programs that reflect emerging "green collar careers" in electric and hybrid vehicles, agriculture and food security, green buildings, renewable energies, sustainable design and architecture, and health and wellness.
- Programs should reflect actions related to working in ecological services and protecting communities from the effects of climate change such as living shorelines, habitat migration, changing plant species, etc. (Madden, 2022, pp. 12-13).

Recommendations related to support from Boards of Education include:

- School boards should evaluate their current policies, strategic plans and board goals and update them to ensure they are aligned with New Jersey Student Learning Standards related to climate change education and other state-wide initiatives throughout the district so it becomes part of the district's culture. The United Nations' Sustainable Development goals and national initiatives that support the New Jersey specific policies also should be addressed.
- School boards should include CC professional learning and curriculum in strategic planning efforts.
- School board members would benefit from engaging in professional learning on CC education prior to making decisions and recommendations regarding school-based CC education plans. This should include decisions and recommendations that are related to the school buildings and grounds, fiscal responsibility, evaluation and hiring of staff that supports policies related to CC education. School board members also play an important role in the process by effectively engaging and educating the community on the topic.
- Boards of education should support professional learning opportunities for staff members, and ensure there is sufficient professional development time allotted to undertake this effort.
- Boards of education should support schools in providing supplementary materials (e.g., books, videos, art supplies) and field trips/field-based explorations to encourage interdisciplinary and multifaceted learning related to climate change.
- Boards of education should support workforce development and career opportunities in green collar jobs in middle or upper elementary school.
- School board members should be prepared to ask questions regarding climate change education to evaluate effectiveness, set goals and achieve financial sustainability (Madden, 2022, pp. 13-14).

The New Jersey Student Learning Standards (NJSLS) were developed on the basis of the above programmatic framework (State of Newy Jersey Department of Education, n.d.).

New Jersey Student Learning Standards

In what follows, I first present the NJSLS core CC ideas and their associated standards, followed by critical analysis of the curriculum framework. The analysis addresses a range of aspects related to questions of epistemology, organization and other key considerations. Table 4.2.4 presents CC Core Ideas and Performance Expectations (the standards), by grade-band and content area.

Table 4.2.4.

Climate change Core Ideas and Performance Expectation in the 2020 New Jersey Student Learning Standards (NJSLS), by year-bands and content areas

Core Ideas/ Enduring understanding	Performance expectations
Kindergarten through Grade 2	
Visual and Performing Arts	
As dance is experienced, all personal experiences, knowledge and contexts are integrated and synthesized to interpret meaning.	1.1.2.Cn10b: Using an inquiry-based set of questions examine global issues, including climate change as a topic for dance.
Artist's appreciation of media artworks is influenced by their interests, experiences, understandings, and purposes. Identifying the qualities and characteristics of media artworks improves the individual's aesthetic and empathetic awareness.	1.2.2.Re7b: Identify, share and describe a variety of media artworks created from different experiences in response to global issues including climate change
As theater is created and experienced, personal experiences and knowledge are synthesized to interpret meaning and analyze the way in which the world may be understood	1.4.2.Cn11a: With prompting and support, identify similarities and differences in stories and various art forms from one's own community and from multiple cultures in a guided drama (e.g., process drama, story drama, creative drama) experience about global issues, including climate change.
People develop ideas and understandings of society, culture and history through their interactions with and analysis of art	1.5.2.Cn11b: Describe why people from different places and times make art about different issues, including climate change
Comprehensive Health and Physical Education	
People in the community work to keep us safe	2.1.2.CHSS.4: Describe how climate change affects the health of individuals, plants and animals.
Science	
All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	K-LS1-1: Use observations to describe patterns of what plants and animals (including humans) need to survive
Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	K-ESS2-1: Use and share observations of local weather conditions to describe patterns over time.
Sunlight warms Earth's surface.	K-PS3-1: Make observations to determine the effect of sunlight on Earth's surface.

Core Ideas/ Enduring understanding	Performance expectations
	K-PS3-2: Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.
Plants and animals can change their environment. Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.	K-ESS2-2: Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. Plants depend on water and light to grow.	K-ESS3-1: Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. Plants depend on water and light to grow.
A situation that people want to change or create can be approached as a problem to be solved through engineering. Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	A situation that people want to change or create can be approached as a problem to be solved through engineering. K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	K-2-ETS1-3: Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
Social Studies	
Physical and human characteristics affect where people live (settle).	6.1.2.GeoPP.1: Explain the different physical and human characteristics that might make a location a good place to live (e.g., landforms, climate and weather, resource availability)
Environmental characteristics influence the how and where people live.	6.1.2.Geo.HE.1: Explain how seasonal weather changes, climate, and other environmental characteristics affect people's lives in a place or region. 6.1.2.Geo.HE.2: Describe how human activities affect the culture and environmental characteristics of places or regions (e.g., transportation, housing, dietary needs). 6.1.2.Geo.HE3: Identify cultural and environmental characteristics of different regions in New Jersey and the United States. 6.1.2.Geo.HE.4: Investigate the relationship between the physical environment of a place and the economic activities found there.

Core Ideas/ Enduring understanding	Performance expectations
When all members of the group are given the opportunity to participate in the decision-making process, everyone's voice is heard.	6.3.2.CivicsPD.1: With adult guidance and support, bring awareness of a local issue to school and/or community members and make recommendations for change
Global interconnections occur between human and physical systems across different regions of the world.	6.3.2.GeoGI.1: Investigate a global issue such as climate change, its significance, and share information about how it impacts different regions around the world. 6.3.2.GeoGI.2: Collect data and consider sources from multiple perspectives to become informed about an environmental issue and identify possible solutions
Computer Science and Design Thinking	
Individuals collect, use, and display data about individuals and the world around them.	8.1.2.DA.1: Collect and present data, including climate change data, in various visual formats.
Computers store data that can be retrieved later. Data can be copied, stored in multiple locations, and retrieved.	8.1.2.DA.2: Store, copy, search, retrieve, modify, and delete data using a computing device.
Data can be used to make predictions about the world.	8.1.2.DA.3: Identify and describe patterns in data visualizations. 8.1.2.DA.4: Make predictions based on data using charts or graphs.
Engineering design is a creative process for meeting human needs or wants that can result in multiple solutions.	8.2.2.ED.1: Communicate the function of a product or device. 8.2.2.ED.2: Collaborate to solve a simple problem, or to illustrate how to build a product using the design process. 8.2.2.ED.3: Select and use appropriate tools and materials to build a product using the design process.
Limitations (constraints) must be considered when engineering designs.	8.2.2.ED.4: Identify constraints and their role in the engineering design process.
Career Readiness, Life Literacies, and Key Skills	
There are actions an individual can take to help make this world a better place.	9.1.2.CR.1: Recognize ways to volunteer in the classroom, school and community. 9.1.2.CR.2: List ways to give back, including making donations, volunteering, and starting a business.
Critical thinkers must first identify a problem then develop a plan to address it to effectively solve the problem.	9.4.2.CT.1: Gather information about an issue, such as climate change, and collaboratively brainstorm ways to solve the problem (e.g., K-2-ETS1-1, 6.3.2.GeoGI.2). 9.4.2.CT.2: Identify possible approaches and resources to execute a plan (e.g., 1.2.2.CR1b, 8.2.2.ED.3). 9.4.2.CT.3: Use a variety of types of thinking to solve problems (e.g., inductive, deductive).
Young people can have a positive impact on the natural world in the fight against climate change.	9.4.2.DC.7: Describe actions peers can take to positively impact climate change (e.g., 6.3.2.CivicsPD.1).
Digital tools and media resources provide access to vast stores of information that can be searched.	9.4.2.IML.1: Identify a simple search term to find information in a search engine or digital resource.
Digital tools can be used to display data in various ways.	9.4.2.IML.2: Represent data in a visual format to tell a story about the data (e.g., 2.MD.D.10).

Core Ideas/ Enduring understanding	Performance expectations
A variety of diverse sources, contexts, disciplines, and cultures provide valuable and necessary information that can be used for different purposes.	9.4.2.IML.3: Use a variety of sources including multimedia sources to find information about topics such as climate change, with guidance and support from adults (e.g., 6.3.2.GeoGI.2, 6.1.2.HistorySE.3, W.2.6, 1-LSI-2)
Digital tools have a purpose.	9.4.2.TL.1: Identify the basic features of a digital tool and explain the purpose of the tool (e.g., 8.2.2.ED.1). 9.4.2.TL.2: Create a document using a word processing application. 9.4.2.TL.3: Enter information into a spreadsheet and sort the information. 9.4.2.TL.4: Navigate a virtual space to build context and describe the visual content. 9.4.2.TL.5: Describe the difference between real and virtual experiences. 9.4.2.TL.6: Illustrate and communicate ideas and stories using multiple digital tools (e.g., SL.2.5.).
Grades 3 through 5	
Visual and Performing Arts	
As dance is experienced, all personal experiences, knowledge, and contexts are integrated and synthesized to interpret meaning.	1.1.5.Cn10b: Use an inquiry-based set of questions to investigate global issues, including climate change, through a variety of dance genres, styles, and cultural lenses.
An artist's appreciation of media artworks is influenced by their interests, experiences, understandings, and purposes. Identifying the qualities and characteristics of media artworks improves the individual's aesthetic and empathetic awareness.	1.2.5.Re7b: Identify, describe, explain and differentiate how various forms, methods and styles in media artworks affect and manage audience experience when addressing global issues including climate change.
As theater is created and experienced, personal experiences and knowledge are synthesized to interpret meaning and analyze the way in which the world may be understood.	1.4.5.Cn11a: Identify, respond to and investigate connections to global issues, including climate change and other content areas in a dramatic/theatrical work.
People develop ideas and understandings of society, culture and history through their interactions with and analysis of art.	1.5.5.Cn11b: Communicate how art is used to inform others about global issues, including climate change.
Comprehensive Health and Physical Education	
Community professionals and school personnel are available to assist and address health emergencies as well as provide reliable information.	2.1.5.CHSS.2: Describe how business, non-profit organizations and individuals can work cooperatively to address health problems that are affected by global issues, including climate change.
Science	
Populations live in a variety of habitats and change in those habitats affects the organisms living there. When the environment changes in ways that affect a place's physical characteristics, temperature, or availability	3-LS4-4: Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

Core Ideas/ Enduring understanding	Performance expectations
of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.	
Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.	3-ESS2-2: Obtain and combine information to describe climates in different regions of the world.
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.	3-ESS3-1: Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.
Energy and fuels that humans use are derived from natural sources and their use affects the environment in multiple ways. Some resources are renewable over time and others are not.	4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.	4-ESS3-2: Generate and compare multiple solutions to reduce the impacts of natural Earth processes and climate change have on humans.
The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers."	5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.	
Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.	
Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.	5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Core Ideas/ Enduring understanding	Performance expectations
Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost
Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs	3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved
Social Studies	
Human activities affect environmental characteristics of places or regions resulting in positive and negative impacts.	6.1.5.GeoHE.1: Use a variety of sources from multiple perspectives, including aerial photographs or satellite images to describe how human activity has impacted the physical environment during different periods of time in New Jersey and the United States. 6.1.5.GeoHE.2: Cite examples of how technological advances have changed New Jersey and the United States (e.g., energy, transportation, communications). 6.1.5.GeoHE.3: Analyze the effects of catastrophic environmental and technological events on human settlements and migration
Regions form and change as a result of unique physical characteristics conditions, economies, and cultures.	6.1.5.GeoPP.2: Describe how landforms, climate and weather, and availability of resources have impacted where and how people live and work in different regions of New Jersey and the United States.
A nation's economy is influenced by its government, human and physical capital, availability of resources, and technological progress	6.1.5.EconNM.2: Use data to describe how the resources and regions in New Jersey and other regions of the United States have impacted economic opportunities
Interactions between humans has led to the spread of cultural practices, artifacts, languages, diseases, and other positive and negative attributes as well as changes in environmental characteristics.	6.1.5.GeoGI.4: Explain how cultural and environmental characteristics affect the distribution and movement of people, goods and ideas

Core Ideas/ Enduring understanding	Performance expectations
In an interconnected world, increased collaboration is needed by individuals, groups and nations to solve global issues. Through participation in the decision-making process (e.g., voting, petitions, contacting elected officials, serving in their community) people can initiate change. Human activities affect environmental characteristics of places or regions resulting in positive and negative impacts	6.3.5.GeoGI.1: Use technology to collaborate with others who have different perspectives to examine global issues, including climate change and propose possible solutions. 6.3.5.CivicsPD.1: Develop an action plan that addresses issues related to climate change and share with school and/or community members 6.3.5.GeoHE.1: Plan and participate in an advocacy project to inform others about the impact of climate change at the local or state level and propose possible solutions
World Languages	
Learning a language involves interpreting meaning from listening, viewing, and reading culturally authentic materials in the target language. Interpersonal communication is the exchange of information and the negotiation of meaning between and among individuals. Presentational communication mode involves presenting information, concepts, and ideas to an audience of listeners or readers on a variety of topics.	7.1.NM.IPRET.5: Demonstrate comprehension of brief oral and written messages found in short culturally authentic materials on global issues, including climate change. 7.1.NM.IPERS.6: Exchange brief messages with others about climate in the target regions of the world and in one's own region using memorized and practiced words, phrases, and simple, formulaic sentences 7.1.NM.PRSNT.6: Name and label tangible cultural products associated with climate change in the target language regions of the world
Computer Science and Design Thinking	
Individuals can select, organize, and transform data into different visual representations and communicate insights gained from the data The technology developed for the human designed world can have unintended consequences for the environment. Technology must be continually developed and made more efficient to reduce the need for non-renewable resources Engineering design is a systematic and creative process of communicating and collaborating to meet a design challenge. Often, several design solutions exist, each better in some way than the others.	8.1.5.DA.3: Organize and present collected data visually to communicate insights gained from different views of the data. 8.1.5.DA.4: Organize and present climate change data visually to highlight relationships or support a claim. 8.2.5.ETW.5: Identify the impact of a specific technology on the environment and determine what can be done to increase positive effects and to reduce any negative effects, such as climate change 8.2.5.ED.1: Explain the functions of a system and its subsystems. 8.2.5.ED.2: Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models. 8.2.5.ED.3: Follow step by step directions to assemble a product or solve a problem, using appropriate tools to accomplish the task

Core Ideas/ Enduring understanding	Performance expectations
Engineering design requirements include desired features and limitations that need to be considered	8.2.5.ED.4: Explain factors that influence the development and function of products and systems (e.g., resources, criteria, desired features, constraints). 8.2.5.ED.5: Describe how specifications and limitations impact the engineering design process. 8.2.5.ED.6: Evaluate and test alternative solutions to a problem using the constraints and trade- offs identified in the design process.
Career Readiness, Life Literacies, and Key Skills	
Collaboration with individuals with diverse perspectives can result in new ways of thinking and/or innovative solutions.	9.4.5.CI.1: Use appropriate communication technologies to collaborate with individuals with diverse perspectives about a local and/or global climate change issue and deliberate about possible solutions. 9.4.5.CI.2: Investigate a persistent local or global issue, such as climate change, and collaborate with individuals with diverse perspectives to improve upon current actions designed to address the issue
Digital engagement can improve the planning and delivery of climate change actions.	9.4.5.DC.8: Propose ways local and global communities can engage digitally to participate in and promote climate action
Grades 6 through 8	
Visual and Performing Arts	
As dance is experienced, all personal experiences, knowledge and contexts are integrated and synthesized to interpret meaning.	1.1.8.Cn10b: Employ a variety of research methods to inform the development of original dances about global issues, including climate change. Articulate ways the research deepened understanding of the topic and how big ideas are expressed metaphorically through dance.
An artist's appreciation of media artworks is influenced by their interests, experiences, understandings and purposes. Identifying the qualities and characteristics of media artworks improves the individual's aesthetic and empathetic awareness.	1.2.8.Re7b: Compare, contrast and analyze how various forms, methods and styles in media artworks affect and manage audience experience and create intention when addressing global issues including climate change.
As theater is created and experienced, personal experiences and knowledge are synthesized to interpret meaning and analyze the way in which the world may be understood.	1.4.8.Cn11a: Research the story elements of a staged drama/theater work about global issues, including climate change, and discuss how a playwright might have intended a theatrical work to be produced.
People develop ideas and understandings of society, culture and history through their interactions with and analysis of art.	1.5.8.Cn11b: Analyze and contrast how art forms are used to reflect global issues, including climate change.
Comprehensive Health and Physical Education	
Advocacy for personal, family, community, and global health can influence and change the interaction of people and their health.	2.1.8.CHSS.7: Collaborate with other students to develop a strategy to address health issues related to climate change.
Science	

Core Ideas/ Enduring understanding	Performance expectations
Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.	MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.	MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization and precipitation, as well as downhill flows on land.	MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. Because these patterns are so complex, weather can only be predicted probabilistically.	MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions
Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.	MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns

Core Ideas/ Enduring understanding	Performance expectations
Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms and living things. These interactions vary with latitude, altitude and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time and globally redistributing it through ocean currents.	of atmospheric and oceanic circulation that determine regional climates.
Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.	MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.	MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused climate change over the past century.
The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.	MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Core Ideas/ Enduring understanding	Performance expectations
Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.	
A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. Models of all kinds are important for testing solutions. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool or process such that an optimal design can be achieved.
Social Studies	
The physical and human characteristics of places and regions are connected to human identities and cultures.	6.2.8.GeoHE.4.b: Use geographic models to determine the impact of environmental modifications made by earlier civilizations on the current day environmental challenges.
In a democratic government, there are multiple processes by which individuals can influence the creation of rules, laws, and public policy.	6.3.8.CivicsPR.4: Use evidence and quantitative data to propose or defend a public policy related to climate change.
Economic decision involves setting goals, weighing costs and benefits and identifying the resources available to achieve those goals.	6.3.8.EconET.2: Assess the impact of government incentives and disincentives on the economy (e.g., patents, protection of private property, taxes).
World Languages	
Learning a language involves interpreting meaning from listening, viewing, and reading culturally authentic materials in the target language.	7.1.NM.IPRET.5: Demonstrate comprehension of brief oral and written messages found in short culturally authentic materials on global issues, including climate change.
Interpersonal communication between and among people is the exchange of information and the negotiation of meaning.	7.1.NM.PRSNT.6: Name and label tangible cultural products associated with climate change in the target language regions of the world.
Presentational communication involves presenting information, concepts, and ideas to an audience of listeners or readers on a variety of topics.	7.1.NM.PRSNT.6: Name and label tangible cultural products associated with climate change in the target language regions of the world.
Computer Science and Design Thinking	
Computer models can be used to simulate events, examine theories and inferences or make predictions. Resources need to be utilized wisely to have positive effects on the environment and society. Some technological decisions involve trade- offs between environmental and economic needs, while others have positive effects for both the economy and environment.	8.1.8.DA.6: Analyze climate change computational models and propose refinements. 8.2.8.ETW.4: Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best.
Career Readiness, Life Literacies, and Key Skills	

Core Ideas/ Enduring understanding	Performance expectations
Gathering and evaluating knowledge and information from a variety of sources, including global perspectives, fosters creativity and innovative thinking.	9.4.8.CI.1: Assess data gathered on varying perspectives), and determine how the data can best be used to design multiple potential solutions.
Multiple solutions often exist to solve a problem.	9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change and use critical thinking skills to predict which one(s) are likely to be effective. 9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
Digital technology and data can be leveraged by communities to address effects of climate change.	9.4.8.DC.8: Explain how communities use data and technology to develop measures to respond to effects of climate change (e.g., smart cities).
Sources of information are evaluated for accuracy and relevance when considering the use of information.	9.4.8.IML.7: Use information from a variety of sources, contexts, disciplines, and cultures for a specific purpose (e.g., 1.2.8.C2a, 1.4.8.CR2a, W.5.8, 6.1.8.GeoSV.3.a, 6.1.8.CivicsDP.4.b, 7.1.NH. IPRET.8). 9.4.8.IML.8: Apply deliberate and thoughtful search strategies to access high-quality information on climate change (e.g., 1.1.8.C1b).
Grades 9 through 12	
Visual and Performing Arts	
As dance is experienced, all personal experiences, knowledge and contexts are integrated and synthesized to interpret meaning.	1.1.12prof.Cn10b: Research global issues, including climate change, using multiple research methods to inform original dances expressed through multiple genres, styles and varied cultural perspectives. 1.1.12acc.Cn10b: Collaboratively investigate global issues, including climate change, to inform the development of an original dance project. 1.1.12adv.Cn10b: Investigate and present ways in which dance can be used to communicate new perspectives and/or realizations about global issues, including global warming.
An artist's appreciation of media artworks is influenced by their interests, experiences, understandings and purposes. Identifying the qualities and characteristics of media artworks improves the individual's aesthetic and empathetic awareness.	1.2.12prof.Re7b: Analyze how a variety of media artworks affect audience experience and create intention through multimodal perception when addressing global issues including climate change. 1.2.12acc.Re7b: Analyze how a broad range of media artworks affect audience experience, as well as create intention and persuasion through multimodal perception when addressing global issues including climate change. 1.2.12adv.Re7b: Survey an exemplary range of media artworks, analyzing methods for managing audience

Core Ideas/ Enduring understanding	Performance expectations
	experience, creating intention and persuasion through multimodal perception and systemic communications when addressing global issues including climate change.
People develop ideas and understandings of society, culture and history through their interactions with and analysis of art.	1.5.12prof.Cn11b: Describe how knowledge of global issues, including climate change may influence personal responses to art. 1.5.12acc.Cn11b: Compare uses of art in a variety of societal, cultural and historical contexts and make connections to global issues, including climate change. 1.5.12adv.Cn11b: Assess the impact of an artist or group of artists on global issues, including climate change.
Comprehensive Health and Physical Education	
Local, state, and global advocacy organizations provide accurate and reliable resources and strategies designed to address common health and social issues.	2.1.12.CHSS.8: Investigate how local, state and global agencies are addressing health issues caused by climate change and share this information in an appropriate setting.
Science	
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.	HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
Resource availability has guided the development of human society.	HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards and changes in climate have influenced human activity.
All forms of energy production and other resource extraction have associated economic, social, environmental and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics and to consider social, cultural and environmental impacts.	HS-ESS3-2: Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

Core Ideas/ Enduring understanding	Performance expectations
The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics and to consider social, cultural and environmental impacts.	HS-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations and biodiversity HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.
Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict and manage current and future impacts.	HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.	HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics and to consider social, cultural and environmental impacts.	HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural and environmental impacts.
Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.	HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Social Studies

Core Ideas/ Enduring understanding	Performance expectations
Economic globalization affects economic growth, labor markets, human rights guarantees, the environment, resource allocation, income distribution and culture.	6.1.12.EconGE.3.a: Analyze how technological developments transformed the economy, created international markets and affected the environment in New Jersey and the nation.
Political and economic decisions throughout time have influenced cultural and environmental characteristics of various places and regions.	6.1.12.GeoHE.6.a:Compare and contrast issues involved in the struggle between the unregulated development of natural resources and efforts to conserve and protect natural resources during the period of industrial expansion.
Human settlement activities impact the environmental and cultural characteristics of specific places and regions.	6.1.12.GeoHE.5.a: Generate/make an evidence-based argument regarding the impact of rapid urbanization on the environment and on the quality of life in cities. 6.1.12.GeoHE.8.a: Determine the impact of the expansion of agricultural production into marginal farmlands and other ineffective agricultural practices on people and the environment.
Political and economic decisions throughout time have influenced cultural and environmental characteristics.	6.1.12.GeoHE.13.a: Construct an argument on the effectiveness of environmental movements, their influence on public attitudes and the efficacy of the government's environmental protection agencies and laws. 6.1.12.GeoHE.14.a: Evaluate the impact of individual, business and government decisions and actions on the environment and climate change and assess the efficacy of government policies and agencies in New Jersey and the United States in addressing these decisions.
Long-term climate variability has influenced human migration and settlement patterns, resource use and land use at local-to-global scales.	6.1.12.GeoHE16.a: Explain why natural resources (i.e., fossil fuels, food, and water) continue to be a source of conflict and analyze how the United States and other nations have addressed issues concerning the distribution and sustainability of natural resources and climate change.
Resources impact what is produced and employment opportunities.	6.2.12.EconET.3.a: Determine how, and the extent to which, scientific and technological changes, transportation and new forms of energy brought about social, economic and cultural changes in the world.
Understanding the interrelated patterns of change by examining multiple events allows for a clearer understanding of the significance of individuals and groups.	6.2.12.HistoryCC.3.b: Explain how industrialization and urbanization affected class structure, family life, the daily lives of men, women, and children and the environment.
Economic globalization affects economic growth, labor markets, human rights guarantees, the environment, resource allocation, income distribution and culture.	6.2.12.EconGE.5.a: Evaluate the role of the petroleum industry in world politics, the global economy and the environment.

Core Ideas/ Enduring understanding	Performance expectations
Demographic shifts and migration patterns both influence and are impacted by social, economic and political systems.	6.2.12.GeoPP.6.a: Make evidence-based inferences to determine the global impact of increased population growth, migration and changes in urban-rural populations on natural resources and land use.
Human and civil rights support the worth and dignity of the individual.	6.2.12.CivicsHR.6.b: Make an evidence-based argument on the tensions between national sovereignty and global priorities regarding economic development and environmental sustainability and its impact on human rights.
Constitutions, laws, treaties and international agreements seek to maintain order at the national, regional and international levels of governance.	6.2.12.CivicsPI.6.a: Use historic case studies or a current event to assess the effectiveness of multinational organizations in attempting to solve global issues.
Global economic activities involve decisions based on national interests, the exchange of different units of exchange, decisions of public and private institutions and the ability to distribute goods and services safely.	6.2.12.EconGE.6.a: Evaluate efforts of governmental, non-governmental, and international organizations to address economic imbalances, social inequalities, climate change, health and/or illiteracy.
Global interconnections create complex spatial patterns at multiple scales that continue to change over time.	6.3.12.GeoGI.1: Collaborate with students from other countries to develop possible solutions to an issue of environmental justice, including climate change and water scarcity and present those solutions to relevant national and international governmental and/or nongovernmental organizations.
World Languages	
Learning a language involves interpreting meaning from listening, viewing, and reading culturally authentic materials in the target language.	7.1.NH.IPRET.8: Demonstrate comprehension of brief oral and written messages using contextualized culturally authentic materials on global issues, including climate change. 7.1.IL.IPRET.6: Using contextual authentic cultural resources, identify reasons for climate change in the target culture and in students' own community. 7.1.IM.IPRET.9: Use information gathered from culturally authentic resources to identify possible solutions to the effects of climate change. 7.1.IH.IPRET.8: Collect, share and analyze data related to global issues including climate change. 7.1.AL.IPRET.10: Collect, share and analyze data related to global issues including climate change.
Interpersonal communication between and among people is the exchange of information and the negotiation of meaning. Speakers and writers gain confidence and competence as they progress along the proficiency continuum.	7.1.NH.IPERS.6: Using information from brief oral and written messages on global issues and exchange information with classmates and others about global issues, including climate change. 7.1.IL.IPERS.6: Exchange information with classmates and with native speakers of the target language about the

Core Ideas/ Enduring understanding	Performance expectations
	effects of climate change on the target language region(s) of the world and suggest a few possible solutions. 7.1.IM.IPERS 6: Exchange information from a variety of resources with classmates about global issues, including climate change. 7.1.IH.IPERS.6: Compare and contrast global issues in a group discussion, with emphasis on climate change and its impact on the target language regions of the world and the people who live in those areas. 7.1.AL.IPERS.6: Converse with members of the target culture with understanding about contemporary global issues, including climate change.
Presentational communication involves presenting information, concepts and ideas to an audience of listeners or readers on a variety of topics. Speakers and writers gain confidence and competence as they progress along the proficiency continuum.	7.1.NH.PRSNT.6: Tell or write a few details about the impact of climate change in the target language regions of the world and compare those impacts with climate change in the student's community and/or different regions in the United States. 7.1.IL.PRSNT.5: Compare and contrast global issues facing the target language regions of the world and those facing the students' own regions. 7.1.IM.PRSNT.7: Compare cultural perspectives regarding the degradation of the environment of the target culture(s), including the effects of climate change, with those of students' own culture. 7.1.IH.PRSNT.6: Explain cultural perspectives of the target language people regarding climate change and compare and contrast those perspectives with ones held by people in the students' own culture. 7.1.AL.PRSNT.6: Analyze how cultural perspectives about climate change over time and compare with changing perspectives in one's own culture.
Computer Science and Design Thinking	
Individuals select digital tools and design automated processes to collect, transform, generalize, simplify and present large data sets in different ways to influence how other people interpret and understand the underlying information.	8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
Development and modification of any technological system needs to take into account how the operation of the system will affect natural resources and ecosystems. Impacts of technological systems on the environment need to be monitored and must inform decision-making.	8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation and propose an innovative sustainable solution.

Core Ideas/ Enduring understanding	Performance expectations
Many technologies have been designed to have a positive impact on the environment and to monitor environmental change over time.	
Engineering design is a complex process in which creativity, content knowledge, research and analysis are used to address local and global problems. Decisions on trade-offs involve systematic comparisons of all costs and benefits and final steps that may involve redesigning for optimization.	8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback. 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. 8.2.12.ED.4: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs and aesthetic and ethical considerations and share this information with an appropriate audience.
Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.	8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics). 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
Career Readiness, Life Literacies, and Key Skills	
Network connectivity and computing capability extended to objects, sensors and everyday items not normally considered computers allows these devices to generate, exchange and consume data with minimal human intervention. Technologies such as Artificial Intelligence (AI) and blockchain can help minimize the effect of climate change.	9.4.12.DC.8: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.
Solutions to the problems faced by a global society require the contribution of individuals with different points of view and experiences.	9.4.12.GCA.1: Collaborate with individuals analyze a variety of potential solutions to climate change effects and determine why solutions may work better than others (e.g., political, economic, cultural).
In order for members of our society to participate productively, information needs to be shared accurately and ethically.	9.4.12.IML.5: Evaluate, synthesize and apply information on climate change from various sources appropriately. 9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender and age diversity.

Core Ideas/ Enduring understanding	Performance expectations
Accurate information may help in making valuable and ethical choices.	9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.

Note. Adapted from https://www.nj.gov/education/standards/climate/learning/gradeband/index.shtml Copyright n.d. by State of Newy Jersey Department of Education.

Analysis of the New Jersey Student Learning Standards

The analysis addresses seven key aspects considered as important in developing CC curriculum. These include conceptualisation and theoretical rational; use of terminology; content scoping, organization and progression; integrative assessment; individual versus collective action; disaster risk reduction; and, consideration of student well-being and addressing climate anxiety.

Conceptualisation and theoretical rational.

CC is conceptualised as a multi-disciplinary topic, appearing across all content areas, in a cross-curriculum approach. The various pieces making up the topic generally tend to be included in "their home" content areas. However, within each content area CC is perceived as interdisciplinary. Pedagogically, the curriculum advocates for authentic learning experiences, consideration of a range of perspectives, and collective action. The Standards state: "Districts are encouraged to utilize the NJSLS to develop interdisciplinary units focused on climate change that include authentic learning experiences, integrate a range of perspectives and are action oriented" (State of New Jersey Department of Education, n.d.).

The curriculum does not provide a rationale for justifying its approach to CC inclusion. There is a conspicuous lack in weighing out alternative options for CC inclusion and using best-practice evidence for guiding the selection of an inclusion approach. For example, there is no indication for considering how the total allocated amount of CC hours may best be utilized and the assessment of benefits and limitations of various inclusion approaches. For example, how do concentrating the allocated hours within one content area weighs against spreading it across many content areas? Answering such questions requires consideration of a broad range of educational theories, including for example, Curriculum Theory, teacher pedagogical content knowledge, and epistemic cognition. Such considerations need to appear up front for allowing debate and evaluation. By failing to present a sound theoretical underpinning for the curriculum framework, the curriculum may be at risk of not achieving its full potential.

Use of terminology.

On the whole, the curriculum presents an attempt to keep the terminology mostly consistent, using the term "climate change". In times of media push toward catchy sensational terms, this curriculum may be commended for its overall consistency in CC terminology. However, two exceptions were found, as follows. In Performance Expectation 7.1.NM.IPERS.6, while the context seemingly relates to CC, the term "climate" appears instead of "climate change", stating: "Exchange brief messages with others about **climate** in the target regions of the world and in one's own region…" (*ibid*, n.d.). Another deviation was found in the visual and performing arts, where the term "global warming" appears instead of "climate change", which seems to be the more appropriate term in this context. Performance Expectation 1.1.12adv.Cn10b states: " Investigate and present ways in which dance can be used to communicate new perspectives and/or realizations about global issues, including **global warming**" (*ibid*, n.d.). However, these two minor deviations highlight the over consistent use of the term "climate change".

Content scoping, organization and progression.

Examination of the contents reveals that the curriculum does not present clear content scoping, outlining the boundaries of CC as a field of knowledge and the contents included within its boundaries. It also mostly lacks internal organisation, as may be expected in any field of knowledge prepared for school delivery, particularly as vast and complex as CC. For most other fields, such as history or biology, this organization would be thematic, where themes are methodologically constructed across year levels. It seems that only the content areas of Science and Social Studies present specified identifiable contents. In all the other content areas, CC appears mostly by its title, giving the reader an impression that CC is metaphorically "sprayed as aerosol" across the curriculum, rather than being methodologically structured and constructed, as content areas should be. In these other content areas, where CC appears primarily as a title, it seems that teachers and students are left to select their own CC contents. This is a cause for worry. Due to the high sensitivity of CC, and the risks it poses to students' well-being (and the development of climate anxiety discussed elsewhere in the report). Furthermore by leaving students to select their own CC contents from the media, the curriculum may be contributing to two media-related risks, which include: developing inaccurate CC conceptions, and developing CC anxiety. In my view schools need to play a remedial role, by which CC contents are carefully selected, and carefully delivered through evidence-based practices, ensuring that the education system provides students with appropriate knowledge, skills and tools for developing emotional and physical resilience, and prepare them well for living in the era of CC.

Lastly, the lack of scoping contents and the lack of internal organization seem to result in lack of clear progression related to concept development, across CC themes and year levels. In what follows, the contents, organization and progression in the various year bands, are analysed sequentially.

Band Years K-2. This band lacks CC content scoping and information organization. Instead, CC appears as a title only, scattered, undefined and unspecified. Thus, leaving students and teachers to select their own CC contents, potentially from media sources. This was found across all content areas with the exception of Science. For example, in Visual and Performing Arts, Performance Expectation 1.1.2.Cn10b states: "Using an inquiry-based set of questions examine global issues, including **climate change** as a topic for dance" (*ibid*, n.d.). Similarly, Performance Expectation 1.2.2.Re7b states: "Identify, share and describe a variety of media artworks created from different experiences in response to global issues including **climate change**" (*ibid*, n.d.). In social Science Performance Expectation 6.3.2.GeoGI.1 states: "**Investigate a global issue such as climate change**, its significance, and share information about how it impacts different regions around the world" (*ibid*, n.d.). In Computer Science and Design Thinking, Performance Expectation 8.1.2.DA.1 states: "Collect and present data, including **climate change data**, in various visual formats" (*ibid*, n.d.). In Career Readiness, Life Literacies, and Key Skills, Performance Expectation 9.4.2.CT.1 states: "**Gather information about** an issue, such as **climate change**, and collaboratively **brainstorm ways to solve the problem**" (*ibid*, n.d.).

Together, these Performance Expectations seem to leave young children to navigate CC on their own, according to their own level of incidentally constructed everyday knowledge. In my view, at best case, it puts children at risk of developing inaccurate conceptions about CC, and at worst case, it puts children at risk of developing CC-anxiety from being exposed to unsupervised potentially threatening contents. As a foundation for further acquisition of structured CC education, this approach seems in my view, potentially more harmful then beneficial.

Interestingly, the term CC does not appear at all in Science. Instead, the curriculum focuses on developing foundational scientific knowledge which will enable students to understand the science of CC in later years. In my view, this approach to teaching CC is appropriate, presenting methodological consideration for knowledge construction and organization in an age-appropriate way.

Grades 3 through 5. In Science the term CC appears only once. Its appearance is limited to the context of studying natural hazards and reducing its impacts. Here for the first time, the reader gets a clear sense of what aspect of CC is being addressed by the curriculum. The rest of the Science

curriculum focuses on developing the scientific foundation for understanding the science of CC in later years. This approach aligns with my own views described elsewhere in this report, by which CC should not be taught in primary schools, except for training students to protect themselves from hazardous CC-related weather events, within the framework of Disaster Risk Reduction (DRR) (UNESCO and UNICEF, 2014).

With the exception of Science, in this year band CC appears in a similar way to its appearance in the K-2 band. It appears as a general term, with no specified contents. For example, in Visual and Performing Arts, Performance Expectation 1.1.5.Cn10b states: "Use an inquiry-based set of questions to investigate global issues, including **climate change**, through a variety of dance genres, styles, and cultural lenses" (*ibid*, n.d.). In Comprehensive Health and Physical Education, Performance Expectation 2.1.5.CHSS.2 states: "Describe how business, non-profit organizations and individuals can work cooperatively to address health problems that are affected by global issues, including **climate change**" (*ibid*, n.d.). It seems quite incredible to think that Years 3-5 would be capable of addressing such a complex question without having developed the necessary foundational knowledge required for dealing with this multi-system global issue. Furthermore this Performance expectation seems vastly remote and disconnected from its associated modest Core Idea, stating "Community professionals and school personnel are available to assist and address health emergencies as well as provide reliable information" (*ibid*, n.d.). In Social Science, two Expectation Performances once again present unrealistic and somewhat risky expectations that students will competently navigate CC complexity and construct effective knowledge. 6.3.5.GeoGI.1 states: "**Use technology to collaborate with others** who have different perspectives to examine global issues, including **climate change** and propose possible solutions" (*ibid*, n.d.); and 6.3.5.CivicsPD.1 states: "**Develop an action plan that addresses issues related to climate change** and share with school and/or community members" (*ibid*, n.d.). Similar general, content devoid and decontextualised Performance Expectations continue to appear in the other learning areas.

Grades 6 through 8. In this year band Science continues to take a lead role in developing specified foundational knowledge for understanding CC. Performance Expectation MS-ESS3-5 specifically addresses the causes of CC as follows: "Ask questions to clarify evidence of the factors that have caused climate change over the past century" (*ibid*, n.d.). The Core Idea associated with this Performance Expectation suggests that mitigation and adaptation involve both human aspects as well as scientific-technological aspects. In all the other Learning Areas, CC content knowledge continues to be presented mainly as a general title, often overly complex and lacking foundational knowledge. For example, Expectation Performance 6.3.8.CivicsPR.4 requires the application of various CC themes including: climate science and technology, economic consideration, and

understanding of climate policy, to effectively meet the expectation to: “use evidence and quantitative data to propose or defend a public policy related to climate change” (*ibid*, n.d.). The curriculum does not specify the foundational content that would allow students to perform according to this expectation. Expectation Performance 8.1.8.DA.6 brings this idea to absurdity when putting forward the expectation that students “analyze climate change computational models and **propose refinements**” (*ibid*, n.d.). Here too, the curriculum does not specify contents relevant to CC models development. Additionally, it is unlikely that students in Years 6-8 have acquired sufficient mathematical and computational knowledge to understand how CC models are produced, let alone **refine** them. Similar patchy and unstructured approach can be demonstrated in PE 9.4.8.DC.8, stating: “Explain how communities use data and technology to develop measures to respond to effects of climate change (e.g., smart cities)” (*ibid*, n.d.).

Grades 9 through 12. In this grade band two learning areas, Science and Social Studies, take a leading role in specifying CC contents. However, while the basic science of CC is presented in a structured way, other CC themes seem mostly bundled together in an unstructured way, making it difficult to identify clear knowledge construction along thematic pathways. CC Science contents include a range of concepts, including for example: electromagnetic radiation from the sun, its reflection, absorption, storage, and redistribution among Earth systems; human activities cause increase in atmospheric carbon causing CC; resource availability and human development; energy and resource extraction and production and associated economic, social, environmental issues; the role of technology and regulation; evaluating solutions in light of a range of considerations; maintaining social sustainability and biodiversity requires responsible resource management; science and technology contributions to solutions; humanity faces major global challenges, such as the need for supplies of clean water, food and energy sources that minimize pollution, which can be addressed through engineering and manifests in local communities. Further Core Ideas relate to developing solutions and models. Social Studies present more focus on the non-science themes related to CC compared to the Science. The contents include for example: Economic and social globalization, economic growth, labour markets, human rights, environment, resource and income distribution, and culture; political and economic decision affect the environment; the expansion of agricultural production into marginal farmlands; CC in the public sphere and in government decisions; effect on public attitudes; government efficacy in relation to CC: natural resources as a source of conflict; the effect of science and technology on social, economic and cultural changes; effects of industrialization and urbanization; the role of the petroleum industry in politics, economy and the environment; population growth, migration and urbanization; national sovereignty and global priorities regarding economic development and environmental sustainability and its impact

on human rights; constitutions, laws, treaties and international agreements. With the exception of Science and Social Studies, across the other content areas, CC once again appears as a general term mostly devoid of contents.

In summary, in the New Jersey CC curriculum, the early year bands are dedicated for establishing foundational scientific and social studies knowledge, where specific CC contents are gradually introduces in year band 6-8 and become highly specific in year band 9-12 in Science and Social Studies. However, with the exception of the science theme of CC, there is no clear thematic organisation, limited identification of thematically related key concepts, and developmental benchmarks. CC science seems to be the only distinguishable theme, where all other matters concerning CC are bundled together as a second theme next to science. The lack of thematic organization of the field of knowledge leaves students and their teachers with the need to unpack the CC complexity on their own. However, our current understanding of students' conceptual development suggests that explicit and thematically organized instruction is required for supporting students in integrating fragmented knowledge into a whole, as well as unpacking complex tightly packed knowledge consisting of multiple concepts, into coherent epistemic concepts (Goldman et al., 2016; Sweller et al., 2019). Thus, the lack of thematic organization limits students' opportunities for conceptual development in CC. To assist students in unpacking the complexity and re-integrating it, as students progress in their conceptual development, CC curriculum needs to be structured along some basic thematic pathways, including for example: Economic theories and applications; societies and culture; governance legislation, political power; ethics and philosophy; and science. While there is a dearth of research into thematic organization of CC and key thematic concepts, it is nevertheless a crucial aspect of any curriculum development, which cannot be overlooked by the developers.

Finally, in learning areas which are not Science and Social Studies, across K-12, CC appears as a title, loosely connected to specific contents. As discussed above, this approach of including unspecified CC contents across all year levels, may put students at risk emotionally, as well as undermine effective learning of CC.

Integrative assessment

The curriculum does not present clear guidelines for developing integrative assessments. Furthermore, as there is no scoping of contents, limited thematic organization of contents, and no clear progression points related to CC contents and skills along thematic lines, it is not clear what contents need to be assessed at what level; how the contents are integrated and at which learning stages.

Individual versus collective action.

On the whole the curriculum conceptualizes CC related action, as a collective action and not as an individual action (the role of behaviour is discussed extensively elsewhere in this report). Furthermore, it refrains from setting behavioural modification goals. This approach aligns well with emerging critique in the literature against the *individuation* approach, calling CC education to move away from framing CC as an individual behavioural problem, which gives students the false idea that they need to take responsibility for solving the problem, by changing their individual behaviour (Jorgenson et al., 2019; Olsson, 2021).

The role of behaviour in collective action is addressed multiple times across the curriculum. For example Expectation Performance 6.3.2.CivicsPD.1 states: "With adult guidance and support, bring awareness of a local issue to school and/or community members and make recommendations for change" (State of Newy Jersey Department of Education, n.d.). Expectation Performance 9.4.2.DC.7 states: "Describe actions peers can take to positively impact climate change" (*ibid*, n.d.) (note that the actions are focused on peers and not the individual). Expectation Performance 6.3.5.CivicsPD.1 states: "Develop an action plan that addresses issues related to climate change and share with school and/or community members" (*ibid*, n.d.). Expectation Performance 6.3.5.GeoHE.1 states: "Plan and participate in an advocacy project to inform others about the impact of climate change at the local or state level and propose possible solutions" (*ibid*, n.d.). Overall, the curriculum does well by contextualising behaviour as an action taken within the public sphere aiming to influence CC policy.

Disaster risk reduction.

The United Nations Educational Scientific and Cultural Organization (UNESCO) and the United Nations Children's Fund (UNICEF) (2014) developed a technical guidance for integrating disaster risk reduction (DRR) in the school curriculum. The guide outlines five essential dimensions of DRR education. These include: "(1) Understanding the science and mechanisms of natural disasters; (2) learning and practicing safety measures and procedures; (3) understanding risk drivers and how hazards can become disasters; (4) building community risk reduction capacity; and (5) building an institutional culture of safety and resilience" (United Nations Educational Scientific and Cultural Organization and United Nations Children's Fund [UNESCO &UNICEF], 2014, p. 11). Here I evaluate the New Jersey curriculum in relation to some of the recommendations laid out in the technical guidance.

A review of the curriculum reveals that DRR is addressed in year bands 3-12, where it is included in Science. This is exemplified as follows: Year 3-5 band, Science Core Idea states: "A variety of natural

hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts" (State of Newy Jersey Department of Education, n.d.). Accordingly, Performance Expectation 3-ESS3-1 states: "Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard" (*ibid*, n.d.).

Year 6-8 Science Core Idea states: "Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events" (*ibid*, n.d.). Accordingly, Performance Expectation MS-ESS3-2states: "Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects" (*ibid*, n.d.). Year 9-12 Performance Expectation HS-ESS3-1 states: "Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards and changes in climate have influenced human activity" (*ibid*, n.d.).

A review of DRR inclusion in the curriculum, suggests that the curriculum primarily focuses on addressing Dimensions 1 and 3 above. Dimension 2, which in my view is the most important of the five, is not addressed. From this perspective the curriculum seems to present hazards as something that might happen to someone else. Not as something that might happen to me and I need to physically and embodilly prepare for it, through drills and other educational methods. The omission of practical preparation to take life-saving measures during CC-related hazards supports the conceptualization of CC as a remote problem, rather than as a local problem, creating a psychological distance between students and the CC threat (Armstrong & Krasny, 2020). This issue is discussed elsewhere in this report. However, suffice to state here that the omission of students' preparation for addressing CC hazards is a critical curricular omission. In my view it is important that curriculum developers pay special attention to preparing students to take appropriate CC-related defensive measures, as early as kindergarten.

Finally, unlike the UNESCO and UNICEF (2014) recommendations, the curriculum does not apply a cross-curriculum approach to implementing DRR. This aspect of CC education is implemented in Science only. For reasons discussed elsewhere, I support this curriculum decision, as it allows more focus and coherency in addressing the issue.

Consideration of student well-being and addressing climate anxiety.

Elsewhere in this report, I devote a chapter for discussing recent research concerning student well-being in relation to CC. Here I focus on analysing this aspect in relation to the New Jersey CC curriculum. The review of the curriculum suggests that it may be putting students at risk of developing CC-anxiety, due to a combination of reasons, including: Early unsupervised and unspecified exposure to CC contents; and the insufficient thematic organization along progression

points in the upper year bands. Concerning the first reason, up until year band 6-8, CC appears with no specified contents. As discussed above, this leaves students exposed to contents that may not be age-appropriate and may be harmful for their well-being. Science stands out as an exception, where year bands K-5 focus on developing foundational knowledge without using the term CC (with the exception of Performance Expectation 4-ESS3-2). In my view Science sets an overall good example which other content areas may follow. The approach taken by Science presents a recognition that complex CC concepts can only be properly understood when constructed on appropriate conceptual foundations. However, as this example is currently not followed by other content areas, it is likely that by the time students begin to study more organized and specifically selected CC contents in Year 6, it might be too late, as some students may have already developed CC-anxiety.

Concerning the lack of thematic organization along progression points in the upper year bands, this aspect may also contribute to CC-Anxiety, for two reasons. The first is that lack of progression points means that as early as in Year 6 students may be exposed to the full gamut of CC contents, leaving them overwhelmed and unprepared both emotionally and cognitively.

Secondly, careful selection of contents in an age-appropriate way and pacing the contents along progression points, provide opportunities for teachers to reflect, pause and adjust their teaching to accommodate students' needs. It also allows teachers to collect formative assessment regarding the ways by which students construct the contents provided to them, and the type of connections made between the various contents. Together, it allows for timely self-correction as teachers gradually present layer upon layer of CC contents. However, such reflection and correction are not achievable when CC contents are packed together and delivered as such. This is because teachers have no way of distinguishing between contents and pedagogies that produce productive emotional outcomes and those that may cause stress and anxiety.

In summary, the New Jersey CC curriculum as reflected in the NJSLS applies a cross curriculum approach for including CC. It is overall consistent in its approach to terminology and in addressing behaviour through collective action rather than through individual action. Epistemologically, CC seems to be conceptualised as multi-system complexity. This is to the extent that the curriculum gives little consideration to the constituents of this complexity. In other words, there is limited attention to CC as a body of knowledge consistent of internal organization, key concepts and principles of knowledge production, verification and integration. As a consequence, across most the curriculum, CC appears as tightly packed multi-system complexity, with limited in-roads into CC themes and the concepts underlying the production of this complexity. This limited thematic organization, may limit students understanding of the rules of organization and the principles

underlying the knowledge production at the multisystem level. In turn, students are likely to conceive CC as a final set of unquestionable truths. In other words, if students are not methodologically exposed to the rules of assembly and the syntactic structure of the CC body of knowledge, they would most likely assume that this assemblage is the only option on the table.

Finally, the analysis suggests that further developments are required in relation to addressing DRR and climate-anxiety, as well as to considering the relationships between these two aspects.

4.2.2.3. Climate Change in California Curriculum

In California, CC is included in the curriculum through the NGSS. CC in the NGSS was discussed above. Additionally, I examined the curricular standards of: English Language Arts & Literacy in History/Social Studies, Science, and Technical Subject; Dance Media Arts | | Music | Theatre | Visual Arts. No mentioning of CC was found.

The State Board of Education has adopted in 2004 a set of Environmental Principles and Concepts, which include five principles, each consisting of a set of concepts. The 2016 California Science Framework claims that every student should learn and be able to apply these principles and concepts. The principles include: (i) “People depend on natural systems”; (ii) “people influence natural systems”; (iii) “natural systems change in ways that people benefit from and can influence”; (iv) “there are no permanent or impermeable boundaries that prevent matter from flowing between systems”; and (v) “decisions affecting resources and natural systems are complex and involve many factors” (State Board of Education Policy on the Teaching of Natural Sciences, 2018, p. 15). Interesting to note that the term CC is not mentioned in the Principles and Concepts.

While CC is not receiving much attention in this document, the notion of environmental literacy is described extensively, advocating that every student needs to be educated “in, about, and for the environment” (*ibid*, p. 34). Further suggesting that every teacher uses “the environment as a relevant and engaging context for teaching their core subjects, especially in science and history” (*ibid*, p. 34).

Overall, In the Californian curriculum CC appears under conceptualised as primarily a scientific problem, narrowly represented as an idea subsumed under other core ideas. There is inconsistent use of terminology. The curriculum does address natural hazards. However, little attention is given to CC related hazards and for preparing students to address them.

4.2.3. Climate Change in the Canadian Curriculum

Bieler et al.'s (2017) examined CC policy documents in the 13 Canadian provinces and territories. Their analysis focused on examining and comparing 13 CC action plans with 90 K-12 educational policy documents of the provinces and territories. Both the CC action plans and the curriculum frameworks were developed independently by each province and territory, and thus may be considered as the highest-level jurisdictions' policy documents of each province and territory.

Their findings revealed that across the 13 provinces and territories there was a consistent gap, by which while CC policies called to enhance CC education, the education policies did not respond to these calls. Overall, their study found that only in 6 of the 13 jurisdictions, CC was mentioned in curriculum frameworks and educational policies. Even then, the CC mentioning were mostly shallow. References to CC were mostly cursory and relatively scarce. There was an over focus on energy efficiency upgrade at schools, rather then on CC curriculum development. Thus, lacking attention to many important areas of CC education. Only in two jurisdictions the educational policy documents had specific objectives related to CC. However, in both cases these were related to school energy efficiency.

Four provinces were selected for deeper thematic analysis. These were Ontario, Québec, Manitoba and British Columbia. The analysis of Ontario's education policy revealed specific goals for energy efficiency. Additionally, CC was explicitly stated in the learning outcomes of Grade 10. CC was addressed in Applied Science, under Earth and Space Science, as follows: 'Analyse effects of human activity on climate change, and effects of climate change on living things and natural systems' (Government of Ontario, 2008, p. 90). Additionally, the 2011 environmental education curriculum guide for grades 9–12 includes CC questions for a wide range of classes from Grade 10 Media Arts to Social Studies and Grade 11 Environmental Science (Government of Ontario, 2011).

In the Québec curriculum, CC is mentioned in the curriculum guide for mathematics, science and technology education (Government of Québec, n.d.). However, the references to CC were few and not strongly connected to learning outcomes. Furthermore, CC is listed as merely an example for other environmental issues, and not as a topic on its own. Furthermore, it is not included in assessments or competency development objectives. The authors further critique the lack of attention to climate justice issues, lack of progression timelines and funding.

In Manitoba, CC appears subsumed under ESD. This is similar to the approach found in Israel middle-years geography curriculum, prior to the 2022 curriculum reform. There too, ESD appeared as an overarching concept inclusive of CC (Dawson et al., 2022). Accordingly, CC is addressed in a resource

guide entitled Education for a Sustainable Future (2000). Here CC is linked to various ESD issues addressed across K-12 curricula. Within the subject-specific curriculum documents, CC appears once in Grade 9 Social Studies (2007). The curriculum guide includes the optional topic 'climate change initiatives and agreements' under the topic 'Canada in the Global Context' (p. 220). In Manitoba's CC action plans, a few of the action goals address education. The action goal that specifically addresses CC education calls for integrating indigenous knowledge into CC curriculum and retrofitting schools for energy efficiency (Government of Manitoba, 2015, p. 40).

Finally in British Colombia CC is conceptualised as a topic of the environment. This finding is similar to the finding obtained from analysing the middle-years science curriculum in Israel, prior to the 2022 curriculum reform. There too, CC was conceptualised as a component of environmental literacy (Dawson et al., 2022). CC appears in the curriculum guides in Grade 10 Science, Grade 12 Geography and Grade 11 Social Studies (2008/2009, pp. 42–48). It is conspicuously missing in Grade 11 Earth Science. CC is not included in language and arts. British Colombia's climate action plan specifically addresses CC education, calling to 'ensure that all our children learn about the science of climate change, as well as strategies for mitigation and adaptation' (p. 73). However, there is little evidence in the curriculum that this goal is realised.

Overall, the findings affirm previous curriculum reviews, suggesting that CC is most apparent in the learning outcomes of science, and less apparent or absent in the arts and other curriculum subjects. However, across all subjects there is lack of integration of cutting-edge CC science. Critical missing aspects of CC education include: CC pedagogy, teacher PD, CC-related disaster risk reduction, and there is minimum attention to CC justice issues. Overall, the study affirms in the context of Canada, findings from other comparative curricula studies, suggesting that the Canadian curricula on the whole present weak engagement with CC contentment. The authors note that "aside from a few environmentally focused curriculum guides and subject-specific resources, curricula seem to be largely ignoring the challenge of integrating climate change across the curriculum" (Bieler et al., 2017, p. 79). The authors further critic the school energy efficiency objectives as being laudable and easily achievable low hanging fruit. This is because it is easier to change buildings than to change curriculum.

4.2.4. Climate Change in England's Curriculum

England has an interesting history of relationships between CC and the national curriculum. Howard-Jones et al. (2021) report that the topic of CC first appeared in the English National Curriculum in 1995 in science. However, in 2011 CC was pulled out of the curriculum, with the claim that science curriculum needs to focus on science. In 2013, following accusations that the government is

purposely not including CC in the curriculum, The Department of Education published in its defence a list of areas in the 5-16 science and geography curricula, where CC needs to be addressed by teachers. Howard-Jones et al. (2021) examined the presence of CC in the curriculum. They found that CC appears as compulsory in Science and Geography at Key Stage 3 (ages 11–14 years); and Key Stage 4 (ages 14–16 years) in Science. CC also appears in the Geography elective at Key Stage 4 (ages 14–16 years). The science curriculum covers the anthropogenic causes of CC, the effects and mitigation. Geography addresses human impacts on changing landscape environment and climate. The authors critique the curriculum for not including the broader impacts of CC on the environment, the economy and society, nor does it address social justice related to CC. They further critique the lack of attention to behavioural aspects and action. Overall, these findings provide further affirmation to Dawson et al.'s (2022) findings regarding the English middle year curriculum in geography and science.

4.2.5. Climate Change in Ireland's National Strategy on Education for Sustainable Development

In 2014 Ireland launched an extensive national ESD strategy, entitled National Strategy on Education for Sustainable Development in Ireland, 2014-2020 (Department of Education and Skills, 2014). The strategy states the key objective

> to ensure that education contributes to sustainable development by equipping learners with the relevant knowledge (the 'what'), the key dispositions and skills (the 'how') and the values (the 'why') that will motivate and empower them throughout their lives to become informed active citizens who take action for a more sustainable future (Department of Education and Skills, 2014, p. 3)

Interestingly, CC is not mentioned once in the fifty pages strategy. However, CC is mentioned in a later 2018 interim report and action plan (Department of Education and Skills, 2018). The report references an earlier 2012 national strategy on sustainable development, entitled "Our Sustainable Future – A Framework for Sustainable Development in Ireland" (Department of the Environment, Community and Local Government, 2012). According to this report, ESD should focus on three key policy areas, one of which is: "environmental issues (climate change; disaster risk reduction; biodiversity; environmental protection; natural resource management; urban decay; water security)" (Department of Education and Skills, 2018, p. 4). Here CC is conceptualised as an environmental issue, alongside other listed environmental issues. Overall, the three policy documents focus on sustainability education in line with UNESCO conceptualization, where CC is subsumed as a topic of ESD. The three national policy documents do not provide any standards or guidelines for CC inclusion in the curriculum.

4.2.6. Climate Change in Singapore Curriculum

In Singapore, the system includes six years of primary school, followed by four to six years of secondary school, and one to three years of postsecondary school. The curriculum for primary schools is common for all students in years one to four. For years five and six, students can take individual courses at the foundation or standard level. Foundational level courses are designed to provide more support for students. Secondary schools consists of three main streams and Special stream. Students are allocated to the various streams at the end of primary school on the basis of their performance in the Primary School Leaving Examination (PSLE). These streams consist of: Express, Normal (Academic), and Normal (Technical). All streams offer the same course of study, but Express is accelerated and Normal (Technical) offers more applied work. The Special stream is designed for students who perform poorly in the PSLE. Students who whish to enrol in university courses stay two more years in secondary school and take A-level courses as part of the Integrated Program (NCEE, n.d.).

Singapore government applies a "soft" government approach for including CC in the curriculum. It was noted that the inclusion of CC themes in the curriculum was a decision made by the subject disciplinary specialists at the Ministry of Education, and not as a response to a top-down directive by higher levels in the government. In other words this decision was made by middle managers in the Ministry of Education. The examination of the curriculum reveals that within the national Singapore curriculum, CC is addressed primarily in secondary school geography. Students learn about the science of CC, the anthropogenic causes, the impacts and responses to CC at the individual, local and global levels (Ho & Seow, 2017). In other subjects CC is addressed anecdotally and less comprehensively. Chang & Pascua, (2017) conducted a detailed examination of CC presence in Science, Geography, General Paper, Economics, and Social Studies in the Singaporean curricula. Their examination reveals that in Social Studies CC appears in secondary Normal (Academic), Express, and Special stream, as a sub-topic of sustainable development.

In primary science, global warming appears in the context of science in daily life, society and the environment. Here students consider human-nature relationships. In secondary school 'O level' science, students study the carbon cycle and its disruption. At 'A level' students study human contribution to CC and its impacts on a range of issues, including for example: ecosystem, biodiversity, biomedicines, global food supply, and public health.

In chemistry 'O level', global warming is discussed under the section 'Atmosphere'. The section discusses how greenhouse gases cause global warming, and the disruption of the carbon cycle. It also addresses mitigation. Chemistry 'A level', expands on hydrocarbon fuels and greenhouse gases.

Physics 'O level' addresses renewable and non-renewable energy sources. Normal (Technical) students study Science as a general subject. CC is not addressed in General Science.

CC was included in the 2007 Upper Secondary Geography curriculum. Geography is offered in secondary schools both as stand alone, or as a component of the Combined Humanities subject. In the 'O' and 'N' levels, in the Combined Humanities CC appears under the key topic Variable Weather and Climate. This topic addresses the causes and impacts of CC. In the stand-alone geography subject, this topic is extended to include responses to CC. At the pre-university level, there is further expansion, which includes examining evidence of CC and responding to CC. The unit further explores the relationships between CC and extreme weather and addresses disaster risk reduction in the context of CC. High level (H1) geography dedicates a special section to CC with emphasis on systems approach for examining atmospheric processes. It addresses the complex human-environment feedback loops. At level H2 these ideas are further developed within a sustainable development framework, pulling together human development, economy, urbanisation and barriers to achieving sustainability.

4.2.7. Summary

This chapter presents a review of approximately 194 national curricula. Both primary sources and secondary sources were used for the purpose of the review. The term CC appears in 53% of countries' curricula. However, these appearances are mostly shallow, with no contents attached to the term. National educational policies on the whole ignore CC curriculum. There is conspicuous lack in curricular frameworks outlining clear rational and approaches to inclusion. CC education is mandated in less than a handful of states and countries. It rarely appears a curricular topic on its own right. When CC concepts appear in the curriculum, this begins to occur mostly in middle years. CC appears most comprehensively in Year 10 curricula. Disaster risk reduction is absent from most curricula. However it is addressed in Years 3-12 in the NGSS. Overall the findings reveal that there are no available best practices for CC curriculum, from which Israel can model its curriculum development.

4.3. Considering the Role of Behaviours in Climate Change Education

At the heart of sustainability education is the idea of behavioural change, by which the role of education is to change students' behaviours. Due to the centrality of this idea, it requires careful examination. In what follows, I first discuss the conceptualisation of behavioural change as a means and as a goal. This is followed by presenting: empirical evidence regarding the efficacy of the approach; literary debate concerning individual behaviour versus collective action; a range of

criticisms against the behavioural change approach, using different lenses of examination; and discussing the relationships between CC knowledge and attitudinal and behavioural change. The findings from this extensive analysis led to reframing the role of behaviour in CC education. Finally, the findings are summarised, and a set of recommendations are proposed.

4.3.1. Behavioural Change Conceptualisation in Sustainability Education Literature

Behavioural change forms a primary goal in ESD and EE (Rousell, & Cutter-Mackenzie-Knowles, 2020). The idea that the learning outcomes of education should include the changing of students' behaviour or encouraging them to take actions has its roots in the early conceptualisation of EE. The 1977 Tbilisi Declaration stated as a goal for EE to "create new patterns of behavior of individuals…" (UN, 1977). Later in the 1980's following debates as to whether or not it is ethical for schools to prescribe behavioral goals, particularly when the desired behavioral outcomes are unclear and contested at times, a new educational model was proposed, shifting the educational goals from prescribed behaviours to what was termed Action Competence (Mogensen & Schnack 2010). This softer approach, while continuing to focus on students' behaviour in relation to their social and physical environment, put more emphasis on the development of capacity to act in the public sphere rather than on prescribing the desired behaviours. However, Blum et al. (2013) report that in the UK both approaches were contested, and it was debated whether schools should be allowed to teach for behaviour, as opposed to helping students to deal with arising uncertainties. However, in current sustainability education literature, behaviour continues to play a central role, where the most prevailing approach is to conceptualise households and schools as "the primary contexts for action and children and youth the primary agents of change" (Jorgenson et al., 2019, p. 165).

In sustainability education literature, behavioural change plays a dual role. It serves both as means to achieve other ESD goals, and as an ESD goal on its own right. **As means**, the basic idea is that if every person changes their behaviour, the world will become sustainable, thus the goal of sustainability may be achieved, through individuals' responsible behaviours. Additionally, individual behavioural change serves as means for mobilising societal change. Thus, individual behaviour has two main manifestations, at the personal household level, where students need to change their individual daily behaviour; and at the societal level, where students are expected to mobilise change in society as a whole, what is often referred to as *agents of change* ((Jorgenson et al., 2019).

As a goal, the rational for behavioural change is that focusing on students' everyday behaviour enables to empower students, increase a sense of agency, and prevent a sense of despair and helplessness (Jorgenson et al., 2019). According to this perception, CC education needs to focus on ""local, tangible and actionable" aspects of climate change that can be "addressed by individual

behaviour" (Anderson, 2012, p. 197)"[2] (Jorgenson et al., 2019, p. 165).

These conceptualisations of the roles of behaviour, as a goal and as a mean, appear repeatedly in ESD literature. For example, UNESCO (2017) suggests that "to create a more sustainable world …individuals must become sustainability change-makers" (UNESCO, 2017, p. 7). This idea is expanded upon as follows:

> ESD aims at developing competencies that empower individuals to reflect on their own actions, taking into account their current and future social, cultural, economic and environmental impacts, from a local and a global perspective. Individuals should also be empowered to act in complex situations in a sustainable manner, which may require them to strike out in new directions; and to participate in socio-political processes, moving their societies towards sustainable development. (UNESCO, 2017, p. 7)

According to UNESCO (2019a), Target 4.7 in SDG 4 Quality Education, aims to "empower learners to assume active, responsible and effective roles to tackle challenges at local, national and global levels" (UNESCO, 2019, p. 2). These ideas connecting individual behaviours to large scale changes in society are further explicated in UNESCO 2020 Roadmap (UNESCO, 2020), where it delineates the role of education as a means "to bring about the fundamental behavioural shift to sustainable development" (p. 9).

> The idea of big transformation implies changes in individual action intertwined with reorganization of societal structures, and it requires ESD to track the transformation… Fundamental changes required for a sustainable future start with individuals. ESD has to place emphasis on how each learner undertakes transformative actions for sustainability (UNESCO, 2020, p. 18).

According to this perception, education has a clear role of transforming individual behaviour, and the achievement of this goal needs to be *tracked* on an individual level. Thus, educational assessment must track each student's behaviour, and measure the individual achievement of this educational outcome. This view of the role of education is referred to in the literature as *Individuation* approach (Olsson, 2021). In the context of this report the term *individuation messaging* is used to describe an educational approach that conveys the message to students that they bear personal responsibility to solving the CC problem through their individual daily behaviour.

[2] Note that this rationale was empirically and theoretically refuted in Chapter 4.1 under the subheading: 4.1.5.5. Cognitive Learning, Socio-Emotional Learning and Behavioural Learning in the Context of the Sustainability Agenda's Goals

The *individuation* messaging is at the heart of the ESD agenda. In its essence it represents a positivist, simplistic view that the whole is a linear sum of its parts, and that if everyone behaves sustainably, the world will become sustainable, and the problem is solved. These ideas were profoundly criticised as discussed below.

4.3.2. Empirical Findings Concerning the Efficacy of Cultivating Behavioural Change at Schools

Studies examining the short- and long-term effects of sustainability education programs on students repeatedly reveal that the efforts to change students' behaviours were unsuccessful. A study examining 38 eco-schools in Flanders, compared to 21 control schools, revealed that in the eco-schools, students' knowledge increased. However, there was no effect on their behaviour (Boeve-de Pauw & Van Petegem, 2013). Similarly, large-scale research on the sustainable schools certification in Canada revealed no effect on students' environmental behaviour (Niebert, 2019). A longitudinal study reveals that students develop pro-environmental behaviours at ages 7-10, and that this effect drops in ages 14-18, regardless of increase in scientifically accurate knowledge (Otto et al., 2019). This suggests that even when educational efforts are successful in increasing intention to act, these effects wear off as children grow. This wearing off may potentially be attributed to increased knowledge about environmental issues, a relationship discussed further below.

One way for explaining the consistent lack of success in promoting individual behaviour, is by drawing upon Weckroth and Ala-Mantila's (2022) discussion regarding socio-spatial boundaries in determining behaviour. This perspective suggests that individual behaviours are never performed in an isolated manner, and they are always socio-spatially bounded. People naturally adopt to the socioecological systems in which they live, and these systems in turn pose constraints on behaviour. It follows, that when considering students' behaviour, there is a need to consider the socio-spatial context that operate beyond the schools and their influence. This means that when students live in an environment which is essentially consumerist in its overall behaviour, it inevitably limits their opportunities for pro-environmental behaviours to the extent that it sends a message that such behaviours are meaningless within their context. Thus, once again pointing to the importance of making changes at the system level, rather than the individual level.

4.3.3. Individuation versus Collective Action

The literature differentiates between *individual behaviour* and *collective action*. *Individual behaviour* includes the range of behaviours that people can do in their private sphere, such as walk or cycle to work, rather than drive a car, or reduce households' consumption.

Collective action refers primarily to participation in social movements related to CC, such as climate strikes (Jorgenson et al., 2019). Unlike the individual behaviour, where people perform certain behaviours mostly related to reducing their consumption, or what is known as *carbon footprint*, in collective actions people come together to express their views and values and exert influence on decision makers that have the power to make changes at the system level. This difference is fundamental in the sense that *individual behaviour* requires people to change their behaviours, whereas *collective action* only requires people to express their views. Thus, teaching for *behavioural change*, puts forward the expectation that students change their behaviour, whereas teaching for *collective action* puts forward the expectation that students express their views in the public sphere. These two learning outcomes are conceptually different, as discussed further below.

The literature does not make the above conceptual distinction. Instead, it questions the value of cultivating individual behavioural change as compared to cultivating collective action, where both are essentially perceived as different forms of behaviour.

Jorgenson et al. (2019) criticises the *individuation* approach and perceive it as a residue from the early EE approach in the 1970's. Furthermore, their review examined how this approach is expressed in educational interventions research. Table 4.3.1. adopted from Jorgenson et al. (2019) presents studies reporting on educational interventions concerning energy conservation and consumption. The review of the interventions clearly reveals that most educational programs focus on behavioural change at the private sphere.

Table 4.3.1

Recent EE research that uses the energy behaviour of individual persons too measure the effectiveness of educational interventions

	Primary focus	Population	Energy behaviors measured	Type (Stern, 2000)
Dijkstra & Goedhart (2012)	Climate change education	Secondary school students	Energy conservation and consumption	Private sphere
Ojala (2012)	Climate change education	Young adults	Energy conservation	Private sphere
Lee, Lin, Guu, Chang, & Lai (2013)	Energy education	Elementary school students	Energy conservation	Private sphere
Clayton, Luebke, Saunders, Matiasek, & Grajal (2014)	Climate change education	Adults	Energy conservation and consumption	Private sphere
Walker & Redmond (2014)	Environmental education	Small business owners	Energy conservation and consumption	Private sphere
Carmi, Arnon, & Orion (2015)	Environmental education	University students	Energy conservation	Private sphere
Barata, Castro, & Martins-Loução (2017)	Environmental education	University students	Energy conservation	Private sphere
Kil (2016)	Environmental education	Adults	Support for renewable energy subsidies	Policy support (individual)
Yang, Lin, & Liu (2017)	Energy education	University students	Persuading people to conserve energy	Non-activist political (individual)
Aguirre-Bielschowsky, Lawson, Stephenson, & Todd (2017)	Energy education	Elementary school students	Energy conservation and consumption	Private sphere
Stevenson, King, Selm, Peterson, & Monroe (2018)	Climate change education	Secondary school students	Support for adaptation and mitigation efforts Energy conservation	Policy support (individual) Private sphere

Note. Adapted from Jorgenson, S. N., Stephens, J. C., & White, B. (2019). Environmental Education in Transition: A Critical Review of Recent Research on Climate Change and Energy Education. Journal of Environmental Education, 50(3), 160–171. https://doi.org/10.1080/00958964.2019.1604478 p. 164

Jorgenson et al. (2019) note that in various studies *collective action*, rather than being perceived as a social collective action in pursuing shared interests, in fact it is simply conceived as the sum of individual actions, such as summation of the number of households that reduced their electricity consumption.

Reimers (2021) criticised the educational focus on influencing individual behaviour, claiming that in effect this is a form of privatising climate action, and

> reinforcing a simplistic and narrow conception of the relationship between climate change, human action, and energy system change and distorting the fact that many of the most impactful climate actions are decisions about energy supply systems that are made by state and market sector actors under direct pressure from advocacy coalitions

and other social collectives (Reimers, 2021, p. 19).

Similarly, Kranz et al. (2022) stress that "greater effectiveness has been attributed to actions in the public sphere than to the actions of individuals" (p.1), where people are exerting pressure on governments to make system changes. However, they observe that in sustainability education, "the responsibility for the emissions is often attributed to large-scale societal actions, while mitigation actions focus on private and technical/scientific strategies and voluntary agreements" (Kranz et al., 2022, p. 20). This approach of delegating the responsibility for mitigation and adaptation to individuals received a range of criticism, related to supporting neo-liberalism, its strategic ineffectiveness, and negative impacts on well-being. These are discussed in what follows.

4.3.4. Criticising the Behavioural Change Approach

4.3.4.1. Individuation Supports Neo-Liberalism

According to the neo-liberal view individuals are autonomous, free to choose a course of action, and thus assumed to be the primary agents of social change through their individual choices. It follows that the unsustainable state of the planet can be attributed to individual choices. Thus, the failure of students to make the correct choices regardless of the efforts of the education systems to encourage them do so, suggests that this must be each student's individual failure (Olsson, 2021).

This neo-liberal worldview was criticised for serving the capitalist market, as it privatises the need for climate action. By delegating the responsibility to individuals, educators may be inadvertently drawing attention away from where the problem actually relies, thus enabling government and industries to continue business as usual (Kenis and Mathijs, 2012; Ojala, 2015).

According to Kwauk (2020) the sustainability education agenda was "co-opted by neoliberal proclivities: Individual action and behavioral change prioritized over collective action and structural change" (p. 10).

> As a result, education systems around the world continued to focus on preparing children, youth, and adults "to join the local labour market to nourish the global marketplace and satisfy corporate needs" (Jickling & Wals, 2008, p. 2)—now under the guise of achieving sustainable development (Kwauk, 2020, p. 10).

The disproportionate responsibility that is placed on individuals is perceived as a neoliberal tactic to evade governments and corporates responsibilities, by diverting the problem to the *down- stream*

symptoms rather than the *upstream* causes (Bellino & Adams, 2017; Uzzell & Räthzel, 2009).

4.3.4.2. The Strategic Ineffectiveness of Individuation

Individual behavioural change is relatively insignificant in impacting CC. When 100 companies across the globe are responsible for 71% of global carbon emissions, what are the chances of any individual action to make a difference on CC matters? (McManus, 2022). An MIT class estimated the carbon emissions of Americans living in vastly diverse lifestyles, "from the homeless to multimillionaires, from Buddhist monks to soccer moms" (Massachusetts Institute of Technology, 2008, n.d.). The findings were clear. The lifestyle made no difference, they all produced more than twice as much greenhouse gas as the global average. They all lived beyond Earth carrying capacity for atmospheric carbon load (Massachusetts Institute of Technology, 2008). This is because the systems they relied on for sustenance continue to discharge carbon disregarding the differences in individual consumption and lifestyles. These findings clearly suggest that the problem is at the system level, and not a linear sum of the individual contributions. So how did it come to be that education systems are so preoccupied with individual *carbon footprint*? Various publications point to a concerted effort since the late 1980's, by polluting companies to purposefully shift public attention from the corporates' responsibilities to individual responsibility. One example is the establishment of the Global Climate Coalition (GCC) in 1989 in response to the establishment of IPCC in 1988, by the UN Resolution 42/187 (1987). The GCC was a consortium comprised of over 40 of the biggest polluting corporates in the United States. Equipped with a total estimated expenditure of $8.3 million, the GCC sole purpose was to manipulate the IPCC and undermine the climate change science. A review of the activities of this coalition revealed that

> the GCC engaged in four distinct activities to obstruct climate action: 1) monitoring and contesting climate science, 2) commissioning and utilizing economic studies to amplify and legitimate their arguments, 3) shifting the cultural understanding of climate change through public relations campaigns and 4) conducting aggressive lobbying of political elites. Through these activities, the GCC played an important role in obstructing climate action, both in the U.S. and internationally (Brulle, 2022, p. 1)

GCC was not alone in the corporate world, as soon after, it became standard practice for polluting companies to hire marketing companies and lobbyists, whose role was to use whatever means available to create the social-political conditions that would allow them to continue *business as usual*. These strategies included media campaigns for convincing the public that if they change their individual lifestyle, the problem will be solved. In other words, rather than the corporates being accountable for their role in causing CC, it is the individual consumer that needs to be blamed and

shamed.

According to a blog, in The University of Melbourne Scientific Scribles (2021) one story describing the propagation of the *individuation* approach goes like this: In the early 2000 the oil company British Petroleum (BP) hired the public relations company Ogilvy & Mather to manage their public image. This company came up with the idea of diverting public attention from the company's emissions to individual households by promoting the concept of *Carbon Footprint*, and the idea that individual households are responsible for leaving those footprints. By 2004, 278,000 were already calculating their footprints, and soon after whole school programs were planned around *carbon footprint* calculations. The success of this idea is captured well in Mulvik et al.'s (2022) claim that the aim of sustainability education is to "empower individuals to reflect on their own actions, taking into account their current and future social, cultural, economic and environmental impacts from both a local and a global perspective" (p.13).

The facts are that individual behavioural change will do nothing to curb CC. A review of past major environmental and social challenges clearly reveals that when changes occurred, they were only due to political and economic decisions, government regulation and law enforcement, not due to individuals changing their behaviours (Eilam & Trop, 2012; Niebert, 2019). This hard-core fact is clearly exemplified in Steinebach's (2022) study. The study examined the air pollutant emissions of 14 OECD countries over a period of 25 years (1990 to 2014). The findings revealed that "only command-and-control (C&C) regulations that are put into practice through well-equipped and -designed implementation structures can be associated systematically with reductions in air pollutant emissions" (Steinebach, 2022, p. 255). All other approaches trialled, including softer approaches aiming to stimulate more environmentally friendly behaviour by "assisting business and individuals by providing information on environmental issues" (p. 227), had no effect whatsoever.

Neibert (2019) further stresses that

> It is not the individual abandonment of CFC-containing deodorants, not the individual change of your electricity provider from nuclear to green energy and not our individual decision to buy an electric car instead of a fossil car, that drives the world into a green state. It is hard political and economic decisions that make a difference (p. 3).

Neibert (2019) further suggests that if we relieve teachers from the need to promote individual behavioural change that doesn't work anyways, they will be free to focus on providing in-depth CC education that addresses the real underlying systemic issues. However, while researchers in the field of CC emphasise change at the political, economic and governance levels, sustainability educators and researchers continue to promote *individuation* regardless of its ineffectiveness (Jorgenson et al.,

2019; Waldron et al., 2019). Even more concerning is that ESD cultivates the unsubstantiated idea that not only individuals can change the course of CC, but also education as a system has the ability and obligation to directly impact system level mitigation and adaptation through *individuation*. This idea is expressed as follows: "Formal education can play a particularly strong role in mitigating climate change, as well as responding to its impact" (Mulvik et al., 2022, p. 10). These ideas put students at risk of developing adverse mental health, as discussed in what follows.

4.3.4.3. The Emotional Impact of Individuation

The *individuation* approach was criticised for repackaging the early 20'th century Behaviorism and bringing it back into schools. Once again we are seeing an educational approach which objectifies students through conditioning methods of rewards and punishment of behaviour, where students are praised for changing behaviour and let to feel guilty if they do not. Critiques of *individuation* claim that "in such approaches, people are considered as objects to be conditioned rather than that they are taken seriously as subjects of change" (Kenis & Mathijs, 2012, p. 53).

Various studies point to the negative psychological effects of the *individuation* approach. Kenis and Mathijs (2012) noted a sense of stress that may be interpreted as an outcome of guilt feelings that arise around the pressure to perform the so-called 'responsible environmental behaviours', as follows:

> One respondent sent us two text messages after the interview, because she remembered a few of her individual actions that she forgot to mention during the interview. Only when we clearly stated that they could interpret engagement in a broad way, from reading about the environmental issue to signing petitions and so on, the respondents seemed to feel relieved, stopped focussing on their own individual behaviour change, and even started to severely criticise this strategy (Kenis & Mathijs, 2012, p. 55).

Hogg et al. (2021) developed and trailed a scale for measuring eco-anxiety. Their research revealed an important distinction between two types of anxiety. The first is anxiety directly related to the state of the environment, and the second is anxiety derived from one's concerns regarding their own impact on the environment. This finding has an important implication for education. It suggests that educational approaches that promote the message of individual responsibility, are increasing the likelihood that students will develop anxiety concerning this issue. Furthermore, Hogg et al (2021) note that "rumination and personal impact concerns may persist to a greater extent over time as they are driven and maintained by cognitions (e.g., thoughts about the environment and one's personal behaviours)" (p. 7). This suggests that inducing students to change their behaviour as means for solving CC, has both short term and long-term effect of causing anxiety.

4.3.5. How does CC Knowledge Relate to Behavioural and Attitudinal-Emotional Changes?

The sustainability education literature suggests that increased knowledge concerning CC goes hand in hand with increased intention to change behaviour (Mulvik et al., 2022; UNESCO, 2021a,b). It is also assumed that by promoting individual behavioural change in everyday context, students will be empowered to become change agents, "increase their understanding and engagement, and avoid the despondency and helplessness that climate change can foster" (Jorgenson et al., 2019, p. 165). The evidence does not support these assertions, in fact it points to the opposite. In what follows, the relationships between increased knowledge and behaviour are discussed first, followed by examination of the relationships between increased knowledge and other emotional and attitudinal aptitudes.

4.3.5.1. The Relationship between Climate Change Knowledge and Individual Behaviour

Research examining the relationships between increased CC knowledge and increased performance of pro-environmental behaviours reveal that the correlations range between negative to weak correlations (Busch et al., 2019; Kranz et al., 2022). The evidence for these relationships come from multiple studies examining multiple aspects of the relationships between CC knowledge and individual behaviour.

A study by Kenis and Mathijs (2012) among 12 environmental activists, found that common to all of them was a sense of powerlessness in the face of CC, and lack of belief in individual action, as means for addressing CC. These environmentally informed people stated that "they used to be very strict on their individual behaviour in the past but became less rigid in this because of their doubts about the usefulness of this type of action" (p. 52). This suggests that people who are at the frontline of working on CC issues have less faith in the usefulness of individual actions to impact the course of CC.

Similarly, the OECD's 2018 Programme for International Student Assessment (PISA) showed that while 79% of 15-year-olds students knew about CC, only 57% of the students felt that they could do something about CC (OECD, 2018). Similar to the findings above among adult environmental activists, The PISA results showed that among youth, increased knowledge about CC is associated with a sense of powerlessness, and less faith in the power of individual behaviours to make a difference (European Commission, 2022; Schleicher, 2021).

Powdthavee (2020) examined the relationships between raising of the minimum school leaving age

from 15 to 16 years of age, and the acquisition of pro-environmental behaviour among 20,000 England-born citizens. The findings revealed that increased level of understanding of the causes of CC did not result in increased intention to behave in pro-environmental behaviours. Furthermore, more education was correlated with more belief that the environmental crisis is beyond control. Powdthavee (2020) concluded that ”although more education had managed to have a desirable impact on the participants' understanding about the causes of climate change, it did not effectively increase their willingness to change their behaviours to help save the environment” (p.13).

A UNESCO (2021b) study among teachers found that while 40% of teachers reported confidence in teaching CC knowledge, only 20% were able to explain how to reduce their carbon footprint. The report concludes that while teachers showed some proficiency in what UNESCO terms the *cognitive dimension*, they were low on what UNESCO terms *behavioural dimension*. Thus, once again pointing to the low association between CC knowledge and individual behavioural change.

Similar results were obtained in a study examining the impact of an educational intervention among 628 Australian adults. The intervention consisted of increasing the participants' knowledge concerning the negative impacts of the palm oil industry on the environment, and the importance of purchasing sustainable palm oil, as well as providing information regarding various behaviours that individuals can perform to help promote the use of sustainable palm oil (Sundaraja et al., 2022). The findings revealed that while the participants' knowledge and awareness about the issue significantly increased, this had no effect on the participants' consumer behaviour, and could have even had potentially negative effect. Contrarily, the control group who received no knowledge and training concerning sustainable palm oil, showed more pro-environmental consumer behaviour in relation to palm oil. The authors suggested that the increased understanding of the complexity of the issue, may have acted to inhibit pro-environmental consumerism (Sundaraja et al., 2022).

Finally, some reports suggest that people who are substantially involved in environmental activism, tend to have lower scientific knowledge about the issues (Rousell & Cutter-Mackenzie-Knowles, 2020). This was demonstrated in Kranz et al.'s (2022) study that found negative correlation between environmental understanding and performance of pro-environmental behaviours. Participants who had higher environmental understanding had a higher carbon footprint than those who were less aware. Furthermore, the study revealed that the best predictor of low consumption is people's income, not their environmental awareness.

One possible explanation for the findings that people who understand more act less, and people who understand less act more, may be that with the growing understanding people get a more accurate appraisal of the situation, and more realistic assessment of their abilities to make a

difference. This leads to the sensible conclusion that individual behaviour will not make a difference in the big scheme of CC. Thus, the findings once again demonstrate that increasing CC knowledge while advocating for individual reduction of resource consumption, as means for solving CC, is ineffective and counterproductive.

4.3.5.2. The Relationships between Climate Change Knowledge and Attitudinal-Emotional Aptitudes

As discussed above, the *individuation* approach has direct negative effects on people's state of mind. However increased CC knowledge seems to also play a role in impacting states of mind, both directly, and in interaction with *individuation*. Studies found associations between increased CC knowledge and reduced states of mind. These states of mind include pessimism, helplessness/powerlessness, apathy, and in some cases also anxiety and depression. Contrarily, reduced CC knowledge is associated with CC denial, scepticism, or naïve optimism.

The 2018 PISA results revealed not only that increased knowledge of CC is associated with less intention to act, but also that the increased knowledge may also be associated with increased pessimism, which in turn may lead to a sense of helplessness (Jensen, 2002, Kenis & Mathijs, 2012).

Clayton (2020) proposed a psychological explanation for the interactions between the three factors: increased CC knowledge, exertion of pressure on students to solve the problem through individual behaviour, and a sense of helplessness. Her explanation suggests a psychological coping mechanism by which when students appraise the problem as not being amenable to solution, yet at the same time they are encouraged to solve the problem through individual behaviour, this may lead to distress, which in turn may lead to a range of responses, including pessimism, depression, anxiety or apathy. Viewed from a different angle, it seems that increased CC anxiety does not lead to more intention to act, but rather to forming barriers and dissociation from CC (Robison et al., 2022).

At the other end of the spectrum is the lack of CC knowledge. Less CC knowledge seems to be associated with scepticism, CC denial, and naïve optimism. In scepticism and denial there is disbelief in the extent of the problem (Busch et al., 2019; Stevenson et al., 2020). In naïve optimism, there is an assumption that the problem is solvable, and that it is likely to be solved (Schleicher, 2021). The literature associates scepticism and denial with low engagement with environmental behaviours, whereas naïve optimism is associated with high engagement in environmental behaviour (Ojala, 2013).

The notion of hope was also addressed in the literature in relation to behaviour. Armstrong & Krasny (2020) suggest that engagement with pro-environmental behaviours is associated with hopefulness about combating CC. Ojala (2013) added the notion of *constructive hope* to signify effective coping

mechanisms versus ineffective. It thus appears that hope may be regarded as equivalent to naïve optimism and can be associated with low CC knowledge on one hand and increased willingness to perform environmental behaviour on the other hand.

4.3.5.3. Clusters of Relationships

The review of the emerging relationships between CC knowledge, behavioural change and mind-sets, in the context of CC educational programs, suggests four clusters of associations. These are presented in Table 4.6.1. The four clusters describe different combinations of level of CC knowledge provided by educational programs, level of *individuation* messaging by educational programs, and students' responses in relation to behavioural change and development of mind-sets related to CC. It is important to note here that to the extent of knowledge no research was carried out to examine and validate these associations. These associations are offered here as a hypothesis requiring further research. Some of the associations have more direct evidence-based support, and some are merely referential, with no direct supporting evidence.

Cluster 1 describes the association between: high CC knowledge, high *individuation* messaging, low behavioural change response and development of mindsets that may consist of pessimism, helplessness/powerlessness, apathy, anxiety, or depression. The evidence for this association is derived from the work of: Boeve-de Pauw and Van Petegem (2013); Hickman et al, 2021; Otto et al. (2019); Niebert (2019); Sundaraja et al., 2022; and others. These scholars provided empirical evidence for the negative relationships between increased CC knowledge, *individuation* messaging and low behavioural change response. Hogg et al. (2021); and Kenis and Mathijs (2012) provide empirical evidence for the negative emotional impacts associated with this cluster. Particularly strong association were found between increased CC knowledge and development of CC anxiety (Clayton & Karazsia, 2020; DeWaters, et al., 2014; Flanagan, 2022; Searle & Gow, 2010). Overall, the associations presented in this cluster are grounded in empirical evidence.

Cluster 2 describes the association between: high CC knowledge, low *individuation* messaging, low behavioural change response and development of powerful knowledge. The evidence-basis for this association is the weakest, however, the theoretical basis seems convincing. The two main scholars contributing to this association are Young (2013) and Biesta (2020). Young's contribution is in relation to acquisition of high CC knowledge, whereas Biesta's contribution is in relation to minimising *individuation* messaging. Young (2013) introduced the notion of *powerful knowledge*, suggesting that quality education equips students with knowledge that prepares students for successful participation in adult life, as this knowledge holds current best understanding of claims of truth. This is "important knowledge that pupils should be able to acquire at school" (Young, 2013, p.

103). Here knowledge acquisition is placed at the centre of the curriculum. Biesta (2022) critiqued learning outcomes based on behaviour modification. The *individuation* messaging stands in contrast to Biesta's claim that "… instead of asking what the schools should "do" for society—which seems to have become the most prominent way in which the task of the school is nowadays being conceived—I ask what society should "do" for the school so that the school can be a school" (Biesta (2022p. 9). Taken together, the removal of *individuation* messaging and the focus on knowledge acquisition holds the potential to provide students with what Young (2013) termed *powerful knowledge*.

Cluster 3 describes the association between: low CC knowledge, high *individuation* messaging, high behavioural change response, and development of Naïve optimism and hope. This cluster is supported by evidence suggesting that when the educational program focuses primarily on *individuation* messaging, with limited provision of CC knowledge, students may respond in changing their behaviour while developing naïve optimism that by this, they are helping to solve the problem (Schleicher, 2021). Evidence supporting this association are derived from Ojala's (2012, 2013) work around coping strategies and the role of hope in CC education. Additionally, Sundaraja et al.'s (2022) findings suggest an association between low level of knowledge and more pro-environmental behaviour.

Finally, Cluster 4 describes the association between: low CC knowledge, low *individuation* messaging, low behavioural change response, and development of denial or scepticism. Here too, evidence for this association is derived from Ojala's (2012, 2013) studies, suggesting that scepticism and denial act as emotional coping mechanism, where some students de-emphasise the threat by claiming that it is exaggerated or denying its threatening potential all together (Ojala, 2013, 2018). Some studies suggest that low level of CC knowledge together with denial and scepticism responses, increase people's vulnerability to media influence and false messaging (Bentley et al., 2016).

Table 4.3.2

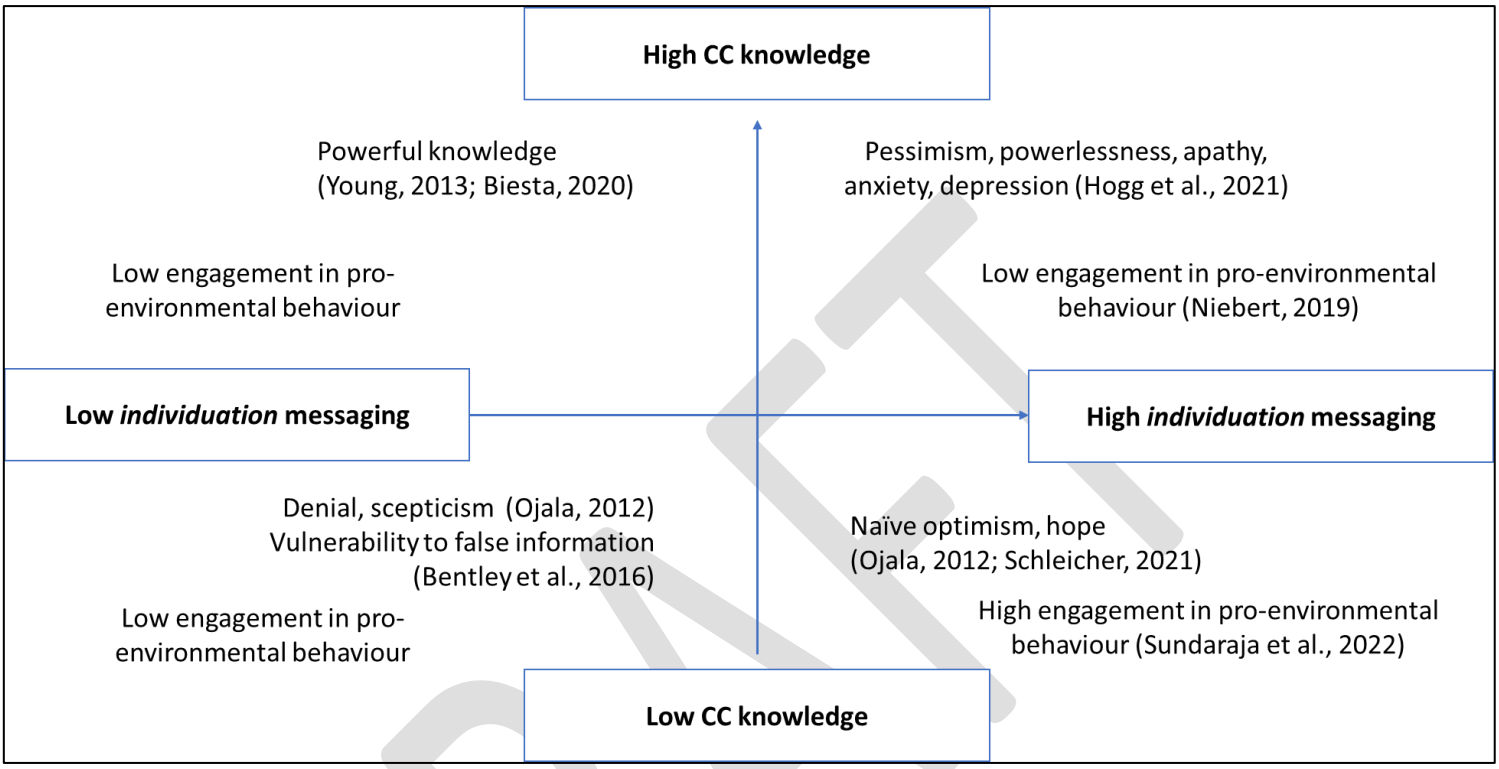
Clusters of associations between School CC educational approach and potential educational outcomes, by level of CC knowledge taught, level of individuation messaging, students' responses in relation to changed behaviour and potential mind states

Cluster No	School educational approach		Educational outcomes	
	CC Knowledge	Individuation messaging	Behavioural change	Mind States
1	High	high	Low response	Pessimism, helplessness/ powerlessness, apathy, anxiety, depression
2	High	Low	Low response	Powerful knowledge
3	Low	High	High response	Naïve optimism, hope
4	Low	Low	Low response	Denial, scepticism

Another way for portraying these associations, is by considering school educational input as varying along two intersecting continuums, where one continuum describes the level of CC knowledge taught from low to high, and the intersecting continuum describes the level of *individuation* messaging from low to high. The four spheres between the intersecting continuums describe different educational conditions, each producing different emergent educational outcomes. These configurations are presented in Figure 4.3.1.

Figure 4.3.1.

Four spheres of knowledge-behaviour-state-of-mind associations, by level of CC knowledge and Individuation messaging input, and student behavioural and state-of-mind outcomes



Overall, there seems to be strong indication that encouraging students to perform individual behavioural changes for the purpose of solving CC is misleading, ineffective and psychologically damaging. However, there is some indication that when collective action is taken, this may not be the case. A growing body of literature suggests that collective action may even protect against anxiety and depression (Schwartz et al., 2022). The issue of anxiety in CC education will be expanded upon elsewhere in this report.

4.3.6. Reframing the Role of Behaviour in Climate Change Education

4.3.6.1. Educating for Earth Ethics: Behaviours as an Ethical Conduct

If the role of behaviour is not to solve the CC problem, then does behaviour have any role at all to play in CC education? Another way of asking this question, is as follows: Why teach behaviours such as refraining from using disposable products or walking to school, if it makes no difference whatsoever in relation to the state of CC?

The proposed answer to this question is: Because this is the right thing to do. These are the norms that we as society whish to instil in our children. These norms reflect what we believe should be the values and ethics that guide humans' relationships with the Earth.

The reason for teaching environmental behaviour at schools should not be different than the reasons for teaching students not to bully each other at the playground. We teach not to bully, not because we wish students to go out into the world and solve countries' territorial conflicts with each other, such as governments' bullying behaviours toward neighbouring counties. We do so, because we wish to raise human beings that are capable of respectful and ethical conduct among each other, and in their communities.

Similarly, we teach students not to bully the Earth by unnecessary consumption, not because we wish them to solve CC, they can't, and it is inappropriate to expect them to do so. We do so because we wish to raise human beings who are respectful of the Earth and express their respect, by not trashing it, and through other forms of respectful behaviour.

Viewed from this perspective, behaviour plays a critical role in ethical education. It is the normative-behavioural expression of the values and ethics that societies believe in and wish to instil in their young generations. It is not a means for solving the CC problem.

The difference between the two views of behaviour is critical. In behaviour as a personal responsibility to solve the CC problem (*individuation* messaging) behaviour has no intrinsic educational value on its own. Here the approach aligns itself well with the neo-liberal utilitarian-instrumental view, with its ethical relativism and the absence of universal ethics, where all things are judged for their utilitarian value. Thus, students are led to judge the worth of their individual behaviours in relation to the extent that they helped solving the CC problem.

In behaviour as a reflection of values and ethics, behaviour has an intrinsic value as a learning outcome. This is no different than the intrinsic value ascribed by society at large to the acquisition of arithmetic as a learning outcome. Here acquisition of norms of behaviour are treated in the same way by which curricula treats knowledge that is deemed important by society. However, unlike knowledge of arithmetic that can be assessed and measures, ethical acquisition forms a tacit outcome of the educational process, not less important than the overt measurable learning outcomes.

The dissociation of behaviour from its utilitarian goal, eliminates many of the negative impacts of *individuation*, outlined above. For example, students will be freed of guilt feelings and anxiousness associated with their behavioural impact on CC. Furthermore, once behaviours are dissociated from saving the planet, students may be more inclined to perform environmental behaviours, as they do

so because it is the right thing to do, not as means to solve CC. It also follows that the association between increased CC knowledge and decreased behaviour will break down. This is because when behaviour is framed as a normative ethical act, it is not aimed to solve CC in the first place, thus its value holds irrespective of increased knowledge regarding its utilitarian uselessness. This was expressed well by environmental activists in Kenis and Mathijs's (2012) study, where "almost none of the respondents said they believe that individual behaviour change could make a real contribution to tackle climate change. The arguments given for this kind of engagement were all of an ethical nature, they were about 'doing the right thing'" (p. 51). Indeed, environmental behaviour is no more and no less than doing the right thing.

Put in a broader context, the role of behaviour will now be discussed in the context of values related to CC. This is followed by discussing the role of behaviour in education more broadly.

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