Article

How Big Is My Carbon Footprint? Understanding Young People's Engagement with Climate Change Education

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Abstract: This paper presents a new engagement model for climate change education (CCE) as a result of analysing interactive digital narratives (IDNs) created during the You and CO_2 Climate Change Education Programme. Young people aged 13–15 from two schools in Wales participated in three workshops, which culminated in students producing IDNs about climate change using Twine storytelling software. An inductive, grounded-theory approach informed by Bourdieusien principles of habitus and value was used to explore students' responses to the Programme. Stage 1 coding identified 'Core Themes' and located student responses along tri-axial continua showing engagement, agency, and power. Stage 2 coding combined 'Core Themes' to build upon Cantell et al.'s 2019 Bicycle Model of Climate Change Education to create a new 'holistic Agentic Climate-Change Engagement' model (h-ACE), where learners' journeys towards full engagement with and understanding of CCE and action could be traced. Barriers to students' engagement with and understanding of CCE were identified through Bourdieusien analysis of responses. Results show that engagement was related to children's views on their capacity to effect change on individual, local and governmental levels. The h-ACE provides a model for adjusting CCE curricula to accommodate young people's varying cultures and views.

Keywords: carbon footprint; climate change education; pedagogy; engagement; Bourdieu; STEAM

1. Introduction

Climate change has resulted in a global temperature increase of 1.1 degrees centigrade in comparison to pre-industrial levels [1]. Mora et al. [2] predict that there will be significant changes to the world which will limit its habitability. However, while these changes are detectable over time, and are recognised by climate scientists globally [3], the individual's ability to engage actively with climate change may be minimal. The barriers to engagement are diverse but, as noted by Höppner and Whitmarsh [4], they are strongly connected to the physical structures and sociocultural settings inhabited by individuals. This paper offers insights into how young people engage with climate change education (CCE), based on qualitative analysis of student-created interactive digital narratives (IDNs) centring on climate change as part of the You and CO_2 (YCO_2) programme [5]. As noted by Arya and Parker [6], to change how individuals understand their self-efficacy in relation to climate change requires open discussion and opportunities to engage with diverse types of knowledge. YCO_2 aims to create a space for such discussions to take place. YCO_2 uses a series of three classroom-based workshops to engage students with the concept of their carbon footprint, and to explore their potential as agents of change through reading and

writing IDNs. The programme aligns with the New Curriculum for Wales, which aims for students to become 'ethical, informed citizens who understand the impact of their actions on Wales and the wider world' [7]. The results reported here indicate that using IDNs for CCE can illuminate barriers to deep, 'holistic' student engagement in the topic, enabling iterative improvements to CCE programmes for increased efficacy. This paper uses Cantell et al.'s 'Bicycle Model of Climate Change Education' [8] to model the journey a learner takes from disengagement with CCE to full and active engagement with it in our 'holistic Agentic Climate-Change Engagement' model (h-ACE Model), discussed herein.

CCE is paramount in ensuring the next generation is both aware of and empowered to act in ways that mitigate climate change. Numerous studies have been carried out to explore how teachers around the world teach climate change and how students respond to such lessons [9–12]. Lasen et al. [12] summarise the literature succinctly: 'ongoing professional learning is required for teachers to develop pedagogies that can promote students' critical and action-oriented engagement, with community partners' (p. 391). Cantell et al. [8] also recommend action-oriented engagement through their Bicycle Model for CCE, noting that CCE must emphasise that humans can change society and that students need to participate in joint positive action and support one another. Rousell and Cutter-Mackenzie-Knowles [13] support this in their recent CCE review, identifying 'the need for participatory, interdisciplinary, creative, and affect-driven approaches to climate change education, which to date have been largely missing from the literature' (p. 1). Whitmarsh and O'Neill [14] argue that the experiences and epistemology of different groups should be considered when engaging with different 'publics', so that any programme delivery is also context sensitive and meets the needs of participants. As such, any programme designed for school delivery must consider context, be attractive to young people, and create space for open dialogue to promote active engagement with CCE.

This paper presents qualitative analysis of student-created IDNs centring on climate change, in particular how the year 8–10 (aged 12–15) students at two schools in Wales engaged with CCE in the YCO$_2$ programme. Ensslin et al. [15] and Yelland [16] have previously studied IDNs, respectively, as interventions to improve teenage body image and literacy; to the best of our knowledge, however, IDNs have not previously been qualitatively analysed for their efficacy as CCE. This analysis of student IDNs aims to uncover the level and type of engagement with CCE that students achieved during the workshop series, with a view to supporting them towards engaging in climate change mitigation actions both at individual and structural level. Through developing an understanding of their engagement (or lack thereof) we aim to uncover potential barriers to students' ability to engage with CCE, to make changes individually, and to act to counter structural causes/roots of climate change. As well as being an important addition to a teacher's toolbox, the findings here address a gap in CCE research. Rabinovich et al. [17] have noted that behaviour change to mitigate climate change is linked to individuals identifying with groups whose social norms promote sustainable practices; they have not explored specific vehicles attempting to prompt that change. Prior CCE work has not attempted to connect external influences on individuals/social actors to CCE, or to explore the interconnectivity of elements of peoples' social settings and lives, and how these affect engagement with CCE.

The following sections summarise our theoretical framework, our method, and the IDNs we collected from students, including Cantell et al.'s 'Bicycle Model for CCE' [8], which we incorporate to contextualise the identity, values and worldview (frame) underpinning the students' experiences and values when engaging with the YCO$_2$ project. We present the results of our analysis, framing them within a new model, 'holistic Agentic Climate-Change Engagement', which allows for a practical, tangible understanding of the different stages of CCE and the elements facilitating movement along the bicycle's pathway from climate change apathy to climate change action.

1.1. Climate Change Education and Class

Education plays a significant role in individuals' understanding of the effects of climate change. Reis and Ballinger [18] conclude that information from climate change organisations (such as the Intergovernmental Panel on Climate Change, or IPCC) is not adequately communicated at the local level. They found that local councillors and individuals who influence future climate change policies needed assistance to understand climate change science and its implications. Laidley's [19] argument that social class affects engagement with climate change offers an explanation for this communication gap, as lower economic classes correlate to lower levels of education. She stresses that social class must be considered in the development of CCE programmes, as misalignment of cultural and economic capital with hegemonic structures leads individuals to doubt their capacity to mitigate effects of climate change. This is not to say that the entire array of socioeconomic classes do not engage in climate change activism; notable efforts are being made by schoolchildren, indigenous groups, wealthy advocates, trade unions, etc. The generalisation merely accounts for the fact that in the UK, school curricula and CCE are largely shaped by a white, middle-class hegemony, and therefore may fail to adequately reach learners of other social groups.

Those who are outside of a particular social group may find it difficult to engage on the topic unless 'climate change messengers' are approachable, understanding that different social groups hold different values [20], particularly given that values linked to CCE are largely middle class (which is perhaps a result of most CCE being created for and used within middle-class environs). Thus 'climate change messengers must be chosen according to their credibility among the target social groups, like decision-makers, politicians, teachers, and so on' [21] (p. 19). Noting that 'human beings are very skilled at denying that which is inconvenient,' Frantz and Mayer argue that climate change must be presented as an urgent problem whose mitigation is nonetheless attainable; engagement with climate change action must therefore be visible, feasible and accessible to individuals [22] (p. 211). They offer the caveat, however, that 'sometimes people do not act because it is structurally impossible (e.g., there is no public transportation one can take to work), sometimes because it is inconvenient . . . But habit and norms also play an important role' [22] (p. 217). This is the case for those with cultural and economic capital that do not view climate change as a problem needing a solution or action [23]. Lack of action to mitigate climate change may also be connected to actors' privileged social positions. While positive engagement with climate change is often associated with middle-class values, Roper et al. [24] note that some powerful/wealthy individuals and organisations act to counter the climate change narrative as a means to maintain their advantageous socioeconomic positions.

1.2. CCE Modelling

Some work has been undertaken into people's capacity to engage with climate change, and effect change [4,17,25]. This work has explored social context and its importance in understanding individuals' perceptions of their self-efficacy to mitigate climate change, and the connection between self-efficacy and government responses to climate change. None of this work, however, has evaluated specific programmes of CCE that explore individuals' engagement with the topic and their potential to act. These papers also do not develop theoretical models for engagement with CCE and connect them to modes of action, linking individual action and policy positions.

CCE is an emerging field of pedagogy, and as such does not have extensive established models for implementation. Nonetheless, we considered two existing models in framing our approach and our analysis within the wider context of CCE: Palmer's 'Tree Model' [26] and Cantell et al.'s 'Bicycle Model' [8]. The Tree Model represents three pedagogical types in a branching structure: education in or from the environment; education about the environment; and education for the environment. While on the surface this seems a comprehensive approach, the Tree Model does not consider external influences on individuals/social actors relating to their engagement with CCE. Given the literature

indicating a class effect on CCE engagement, we discarded this model as lacking in scope for examining YCO$_2$'s efficacy.

Cantell et al.'s 'Bicycle Model' [8] is an exception, as it provides a holistic understanding of CCE to inform programme development and delivery. Designed for both theoreticians and educators to consider and implement, this model uses the image of a bicycle to convey CCE as a vehicle carrying CCE students from unfamiliarity to awareness and action. Each part of the bicycle corresponds to an element important for effective design of CCE programmes [8] (pp. 3–5):

- Wheels: knowledge and thinking skills.
- Frame: learner identity, values, and worldview; provides a foundation to accommodate new knowledge and skills.
- Chain: transferring new knowledge and skills into practical action.
- Pedals: putting individual effort into propelling the new knowledge to action.
- Saddle: learner's motivation.
- Brakes: barriers to action.
- Headlamp: hope and positive emotions, showing the way forward.
- Handlebars: orienting learner toward the future.

While the Bicycle Model incorporates a deeper understanding of the CCE learner's habitus than the Tree Model, it has limitations in its scope. For instance, though the model is thorough and useful for programme design, it does not offer a framework for analysing different types of response to CCE within a cohort participating in the same programme. As such, while this model was invaluable for designing the YCO$_2$ CCE programme, we identified a need to broaden our conceptual framework to a deeper sociological perspective in order to appropriately analyse the student responses to the workshops. The following section discusses the Bourdieusien approach we adopted to parse how the students' responses expose their barriers to CCE engagement, as well as how to overcome these barriers in practice.

1.3. Incorporating Social Values to CCE

As noted by Rabinovich et al. [17], social groups and 'belonging' affect how individuals value and engage with climate change. Given these structural limitations on individual action and capacity to engage with CCE (depending on their cultural norms and value systems), we have underpinned the data analysis in this paper with a Bourdieusien framework, which situates students' capacity to engage with a particular topic according to the cultural expectations (habitus) and value systems within the field of education [27]. (We note engagement capacity may also be affected by curricular content [28], and/or good/poor pedagogical practice [29].) Bourdieu's sociology is an 'almost self-conscious intervention' that explores inter-agentic social relationships within a field and delineates factors affecting actor/group responses to structures [30] (p. 62). The key feature of Bourdieu's sociology is its consideration of both the observed 'subject' (i.e., student) and the structures affecting their reactions (i.e., social class, curriculum), how they are inculcated towards certain behaviours, and how habitus informs value systems of their position within any social field [27,30]. As a core aim of the YCO$_2$ project is to inspire young people to individual action and structural change regarding the climate crisis, this sociological perspective is thus well suited to frame the analysis.

In the context of CCE, it is useful to consider Bourdieu's concepts of habitus, practice, and field [31] as they link to 'values'. Bourdieu [27] views education as a site of (re)production of social roles and structures. The habitus social actors embody results from and allows them access to their roles. Where individuals or groups are positioned disadvantageously within a social field, education can be an oppressive and coercive force. Those in advantageous positions are freer to enact individual agency, exerting power/influence over others, and can meaningfully engage with institutional structures within that field. Where social actors are positioned less favourably, such habitus is inaccessible, meaning they are less able to enact agency and engage meaningfully with governmental structures. Within

any given setting, a set of practices (behaviours, cultural norms, and understandings) form the ethos and values: what is important and requires action. In the context of this study, education is understood as a site, where young people are supported to engage with structures and values in their local communities at first, as they develop understanding and engagement with wider, global structures. Education, however, may not always facilitate this growing engagement; Bourdieu's notions of habitus and practice are thus useful tools to define and examine existing barriers (both social and educational) to young people's engagement with CCE.

The complexity of tailoring CCE to account for its subjects' social class and culture cannot be understated, given the need to link global issues with local concerns that may or may not be salient [9]. Where a student's sociocultural norms do not align with their school's (or the CCE program's), the respective value systems 'clash' in a 'dialectical confrontation' [32] (p. 290). The IDNs the students submitted on the YCO$_2$ project allow an examination of their views on feasible actions to counter climate change; instructions to the students were to use the given IDN software (Twine) [33] to make a story somehow centred on climate change. Though it is pertinent to note that the students had a demonstrable framework for creating their IDNs, as they authored them in their school habitus rather than personal, and they had the model of the programme IDN (with a similar habitus) to work from, the open creative remit permitted them to engage with the topic from the salient perspective of their choosing. Analysis of these IDNs can thus shed light on the students' embodied value systems and habitus.

1.4. Digital Narrative for CCE

The IDN created for YCO$_2$ was purposefully designed to both entertain and educate, for various reasons discussed in depth elsewhere [34]. The key design aims of the IDN were that it connected to the target audience (young people 12–15 years old) personally and emotionally, that it appeal to them as a story/game outside of its assignment in a teaching environment, and that it convey their range of potential agentic actions regarding climate change. Entertaining narratives have been shown effective in educating target audiences on topics of environment and health [35], and interactivity has been subject to intense pedagogical scrutiny as 'serious games' become more commonplace in learning environments [36–40]. Work on multiliteracies [41,42] has illustrated the benefits of multimodal and multisubject pedagogical techniques, combining different learning areas (reading, writing, chemistry, medicine, mathematics, programming) and offering several points of access through diverse media and communication methods (text, visual, game play, discussion, etc.). Our primary purpose in integrating both reading and writing IDNs in the YCO$_2$ programme was to engage the students in an entertaining and engaging story that allowed them to explore their own emotions, actions, and agency regarding climate change.

It is important to note, however, that the YCO$_2$ program, including its IDN, was designed within what CCE literature frames as a typical CCE habitus: white, middle class, and relatively homogenous in terms of education, background, and economic circumstance. As it was envisioned with the aid of teachers in one of the pilot schools, and based on the New Curriculum for Wales, it aligns with the habitus of the schools used in this study.

1.5. Research Aims and Objectives

Given the urgency of addressing climate change, it is vital that we have an understanding of young people's perspectives and reactions to climate change. The Curriculum for Wales [7] aims for young people to 'show their commitment to the sustainability of the planet'. The YCO$_2$ project directly addresses this aspect of the curriculum through a programme of study designed to help students engage with the concept of climate change and how their actions affect it. This paper draws on IDNs as the outputs of the school-based workshops to explore young people's responses to the programme through a

Bourdieusien based-grounded theory analysis. Young people's IDNs allow for exploration of the following:

- Their embodiment of and reproduction of habitus/values associated with climate change education.
- Young people's perception of their own capacity to enact change in their lives.
- Young people's perception of their capacity to engage with peers and other individuals to act to mitigate climate change.
- Young people's perception of their ability to and the efficacy of engagement with governmental structure to promote mitigation of climate change.

2. Materials and Methods

As the use of IDNs for CCE is a little-researched topic area [43], we approached our qualitative analysis with grounded theory [44] in order to base our conclusions thoroughly in the data set present. This section outlines how we collected and analysed the data, framing it with Bourdieusien theory and the 'Bicycle Model of CCE' [8].

2.1. Data Collection

The data analysed in this paper are the output from the third workshop of a series of three on climate change, developed by researchers in chemistry, psychology, pedagogy, and digital writing. A description of all the workshops, along with a discussion on their effectiveness, is detailed in Rudd et al. 2019 [5], and the project IDN and samples of student IDNs can be found on the project website (http://youandco2.org (accessed on 10 December 2020)). In this workshop, students used the open-access, internet-based authoring software Twine to create IDNs based on the topic of climate change, either as individuals or as groups. Students then voluntarily uploaded their IDNs to the YCO_2 website.

Data collection occurred in two different secondary schools in Wales. The following subsections describe each school's social context as well as workshop implementation differences between the two schools. The schools and participants have been given pseudonyms in order to maintain anonymity in line with BERA ethical guidance [45].

2.2. Valley School Context

Located in South Wales in a relatively affluent area, Valley School is a relatively large school with 1800 students on roll (400 in sixth form). It was graded 'Excellent' in its most recent Estyn inspection [46]. The proportion of students having 'Additional Learning Needs' (ALN) is 12% (compared to 22% nationally) and those with 'Free School Meals' is 6% (17% nationally). Proportionally, few students live in areas of deprivation and 25% are from ethnic minorities with 20% having 'English as an Additional Language'. The school's 2018 Estyn Report describes Valley School students as enthusiastic learners with outstanding attitudes to learning. Their interactions with staff, external visitors and peers are noted as respectful and polite. The school's ethos is that students can engage in decision-making processes through the 'School Advisory Board' and in the wider community through the school's social, spiritual, cultural, and moral education programmes (ibid.), with the expectation that students actively engage in ethical debate. According to their most recent Estyn Report, Valley's Key Stage 3 literacy skills are strong, and students are reported as able to tackle 'real-life' problems confidently.

Eighty-five students from three high-ability Year 9 classes (aged 13–14) participated in three workshops, each 50–60 min (one lesson) in duration, approximately one month apart. The first workshop introduced CO_2 and its effects to students, through instructor-led question and answer sessions. Some students may have found engagement with the session difficult, as confident students were surmised to be more prominent. In Workshop 2, the YCO_2 project IDN, *No World 4 Tomorrow*, was presented to the students to spark discourse relating to climate change and incorporating sustainable choices in their own lives. Sharing computers and slow internet, as well as difficulties accessing the project website (http://youandco2.org/ (accessed on 10 December 2020)), impeded the smooth

running of the workshop and thus students' engagement. Following Workshop 2, students' homework assignment was to plan their own IDN. Only one group completed this activity, however; the other groups had to use Workshop 3 time to mindmap and plan, rather than dedicating the time writing their IDNs. Many stories were consequently unfinished at the end of the programme.

2.3. Heighton School Context

Heighton School is a 9–18 independent school in the north of Wales, with circa 200 students. Approximately 30 students are in the primary section and 40 in sixth form [46]. Some 68% of students come from the school's vicinity and 32% are international, coming from 16 different nationalities with 'English as an Additional Language'. The report does not include the proportion of students having ALN and/or a Statement of Educational Needs, and no students qualify for free school meals, as the school is an independent school. While school costs are high and many students have an affluent background, some students have subsidised places through the school's bursary scheme.

The school was graded between 'Good' and 'Adequate and Needs Improvement' in its most recent Estyn inspection. It was noted that students are keen learners with excellent behaviour. However, some learners' progress is slower than expected as teaching is not differentiated appropriately to meet their needs and abilities. Assessment of learning needed improvement and language and literacy skills were found to limit students' ability to access the curriculum. Students have a global outlook but their opportunities to engage in decision-making processes in school and the local community are in their infancy and developing.

Participants from Heighton were from years 8, 9, and 10 (aged 12–15). Workshop 1 was presented via group activities in place of instructor-led sessions to facilitate students' peer-to-peer engagement. The workshops were delivered over three successive days. This meant the topic was fresh in students' minds but that there was no time for students to undertake the homework assignment in preparation for Workshop 3. ICT difficulties at Heighton centred on the school's use of digital tablets in an array of brands and operating systems, rather than laptop or desktop computers, which resulted in numerous and unique problems accessing and using Twine (via the touch-tap interface) and downloading, saving, and uploading their IDNs to the YCO_2 website. Students chose to collaborate on their IDNs, working in groups and sharing tablets. While students could all use Twine effectively, instructors noted that many students had 'English as an Additional Language', potentially limiting students' ability to fully engage with workshops. Workshop 1 lasted approximately 60 min, and Workshops 2 and 3 each lasted two hours.

2.4. Qualitative Data Analysis

CCE is a relatively new field, where little research has been undertaken [43]; certainly IDNs as CCE have never been systematically evaluated. As such, suitable approaches for analysis of YCO_2 data cannot rely upon pre-existing theory, and must enable an inductive process based in the data set itself. We therefore incorporated a 'grounded theory approach' to our qualitative analysis, which can be used to generate new theory [44]. We framed the researcher as a 'blank slate' (ibid.): the primary analyst actively avoided any exploration of young people's responses to CCE as well as any other CCE-specific pedagogical models prior to initial data analysis. The primary analyst did, however, conduct a foundational literature review on the concept of CCE in order to appropriately situate the 'core categories' [47] uncovered through initial data analysis.

Students from both schools submitted a combined 85 IDNs, published from Twine to internet browser-playable HTML files, to the YCO_2 website following their participation in the workshops during the 2018–2019 academic year. Sharing their stories was voluntary and some participants declined to submit their stories to the researchers. From the files supplied, 79 contained text referring to climate change or associated issues, and were analysed (48 from Valley School and 31 from Heighton). The six that were not analysed

were either duplicate files, contained no text, or made no reference to climate change. The primary analyst used Google Chrome to display and test the student IDNs' functionality, recording their status as compete, incomplete, or unclear. She then transferred each IDN into Microsoft Word 365 files for open coding. She documented the overall topic/theme of each IDN's story.

The primary analyst coded the data in two stages, using a grounded theory approach. In the first stage, she conducted one reading of each IDN and identified commonly occurring themes, using these to develop 'core categories' [47]. In the second stage, she conducted two further readings of the IDNs before reaching a data saturation point, using the categorised themes to develop a working model of responses for each school. She specifically noted any demonstration of student engagement with (1) knowledge relating to climate change; (2) enacting individual agency to affect climate change; and (3) the role of government in addressing climate change and their ability to engage with governmental structures. (Stage 1 and 2 categories and themes are noted in the Results and Discussion section below).

Once she reached the data saturation point and completed the coding, the primary analyst entered the third stage of data analysis: Bourdieusien analysis of the emergent themes. This approach arose from the analyst's own background, and through this lens she was sensitised to recognise power imbalances, and structural barriers and/or facilitators to participation/engagement with climate change action. She identified social barriers to and facilitators for CCE, framing these within Bourdieu's theories of habitus and practice, and their link to values [31,32]. She reviewed the IDNs twice more within the full coding framework context, as well as the separate school contexts as described above.

This combination of grounded theory coding and subsequent Bourdieusien analysis enabled the primary analyst to develop a model describing CCE learners' progress from shallow engagement with the topic to full, active engagement. This model, along with the core category themes and coded responses, their meaning and their theoretical and practical implications, are discussed in the following section.

3. Results and Discussion

The varying thematic responses from learners reveal different levels of agency, power, and engagement with the knowledge presented in the YCO_2 programme. In this section, we identify the themes coded from the student IDNs in each of the three stages of qualitative data analysis, offering examples and rationales for each of the resulting six response types. We would note that these categories are neither fixed nor discrete, and individual student IDNs may express more than one category; likewise, further themes may be identified in future programme iterations. These types are examined in depth to extrapolate the demonstrated barriers and facilitators to active and holistic engagement with the YCO_2 CCE programme. The interpretation and discussion of each type is a thematic interpolation of the student IDNs for the purpose of providing an indirect indication (as opposed to the direct evaluation of surveys) of the range of possible responses. Most importantly, this thematic approach enables identification of 'bridging' areas where climate change educators can adjust their programming to better reach students across a wider range of habitus.

3.1. Response Types by Stage

Stage 1 grounded theory coding of the student-submitted IDNs identified two core categories of emergent themes: fight and flight reactions to climate change, such as taking action to combat the crisis or abandoning the planet. Stage 2 coding further refined these categories into six types of story-specific responses to climate change:

- Fight-Denial: deny climate change, often demonstrating a lack of understanding.
- Fight-Individual: modify personal choices and behaviours.
- Fight-State: urge government action without modifying personal choices.
- Fight-Holistic: modify personal choices and urge governmental action.

- Flight-Social: leave Earth through individual effort but as part of a group.
- Flight-State: leave Earth through a government programme.

Stage 3 Bourdieusien analysis typed these responses into either 'dominant' or 'bridging' themes. Dominant themes reveal aspects of the learner's habitus, demonstrating that students' own value systems were not in tension at that point, and revealing the type of agency (individual or structural) they felt possible or feasible. Bridging themes highlight areas where dialectical confrontation [32] between the learner's values and the YCO$_2$ programme values occurred, indicating points where the learner's understanding of climate change was evolving, and thus their engagement in the CCE programme deepened. While less common than the dominant responses, bridging themes illuminate areas where the learners have allowed for modification of their habitus, embodying and enacting the value system of the unfamiliar habitus, advancing their understanding that climate change is a social—and indeed, global—challenge.

Dominant:

- Fight-Denial: deny climate change, often demonstrating a lack of understanding.
- Fight-Individual: modify personal choices and behaviours.
- Fight-Holistic: modify personal choices and urge governmental action.

Bridging:

- Fight-State: urge government action without modifying personal choices.
- Flight-Social: leave Earth through individual effort but as part of a group.
- Flight-State: leave Earth through a government programme.

3.2. Response Types: Examples and Rationales

3.2.1. Fight-Denial (Dominant)

In IDNs showing relatively poor engagement with and understanding of climate change, students rated the individual's potential to mitigate climate change negatively. As messages classifying climate change as 'urgent' and needing action are often framed within middle-class values and habitus [9,19], students who do not embody these values may experience a level of discomfort when confronted with them, leaving them unable to engage with CCE. They may convey this discomfort by mocking the topic, emphasising this habitus clash by acting contrary to social rules of their setting (school) [48]. This mockery is demonstrated in their IDNs via the tone of their language used or the absurdity with which they fulfilled the task. Below is an excerpt from 'CO$_2$ Ini' by lonlis2; the student(s) engaged with the topic, but their response demonstrates sarcasm and mockery:

[start] Shalom, Jackie. It is december 31st 2011. You are at morrisons, what do you buy?'

[watermelon] A delious nutritious snack, good for you!

Sike watermelon COMES IN ONE USE PLASTIC. YOU HAVE DOOMED THE PLANET

Heighton School responses were more evenly distributed between the dominant themes, with the largest proportion of responses lying in the Fight-Denial category. Initially this seems incongruous with the fact that the school is a fee-paying independent school; usually such a school would embody the UK's hegemonic white, middle-class values within their ethos [31,49]. This in turn should lead students towards full and active engagement with climate change education and action. Although many students at the school are British, international students form 32% of Heighton's student body. While students at the school generally come from very affluent backgrounds, their familial or cultural values may not align with those of the school: climate change may not be perceived as an urgent problem [22].

The high number of responses indicating a poor level of engagement with the YCO$_2$ programme at Heighton indicates that either the students were not able to understand the material, or they found it inaccessible [48]. Alternatively, the programme design did

not sufficiently incorporate the cultural habitus and values [21] of Heighton's diverse student body. Given that the instructors worked through the material with the students, their regular teachers were present to supplement, and these teachers indicated the programme material was suitable for the student group, we find the latter explanation more compelling. As noted by Whitmarsh and O'Neill [14] (p. 5), denial of climate change can be a 'psychological reaction to the uncomfortable dissonance individuals experience when confronted with the impact of their (carbon-intensive) lifestyles and their reluctance (or inability) to change their behaviour'. Roper et al. [24] argue that not all resistance to mitigation of climate change takes place within oppressed social groups. They argue that that individuals and institutions in positions of power act to undermine the severity and very existence of climate change in order to protect their own business and social interests. Thus, where wealthy/powerful individuals do not engage with CCE, the roots of their resistance may be connected to discourses which act to counter engagement with climate change. The dialectical confrontations between these students' existing habitus and values [31] and those encouraged in the project workshops were likely too significant, causing distress and lowered engagement. This result reflects Laidley's argument [19] that CCE undertaken without consideration of cultural and social values is ineffective.

It is important to note that the submitted IDNs demonstrate few difficulties with Twine as a learning tool. Their IDNs displayed few faults, suggesting the topic area itself presented a barrier, rather than this new educational tool. The IDNs were anonymised for the protection of the student identities, so it is impossible to ascertain the proportion of students whose linguistic/literacy skills may have impeded their engagement amongst the submitted Fight-Denial IDNs. It is likely, however, that a proportion of these IDNs were written by 'English as an Additional Language' students.

3.2.2. Flight-Social (Bridging)

In IDNs with Flight-Social themes, protagonists' individual agency drove them to flee with a group to a safe location unaffected by climate change, exemplified by 'Story Time with Fleur' by ewoama23, kellyn27, ffojay10 and verjil05: '[Story no.2] they decided to stick up for themselves and start a group.' These IDNs demonstrate student exposure to a habitus they cannot engage with. Belonging to a group of peers gave the students (as shown through their protagonists) value [50], bridging their lack of understanding of the topic with an investment in group habitus.

Flight-Social IDNs were most commonly group-authored, suggesting that the formation of a subgroup allowed students to collectively embody a habitus promoting personal action to combat climate change. The space for the modified habitus was situated within the subgroup rather than within the individual; thus Flight-Social themes provide a key bridging stage for climate change educators, indicating a barrier to understanding the topic even while students attempt to engage more deeply. By addressing this barrier, CCE programmes can enable students to progress towards a more active engagement with climate change.

3.2.3. Flight-State (Bridging)

Although Flight-State presented in only one IDN, it demonstrates an important transition between the types of agency students perceive. In 'The Journey to Saturn', connik29 and chesue23 demonstrate some understanding of climate change and engagement with the YCO$_2$ programme. They also make the step of drawing on governmental action as a means to combat climate change:

In six months the government will extract all the air from the atmosphere, move all sources of food and drain all sources of water and take it to the shuttle, to send of 1/3 of the population to Saturn . . .

The action proposed here suggests that these students view climate change as urgent (Frantz and Mayer 2009), but do not perceive individual action as possible. The value systems and power structures of British educational institutions are largely white and

middle class; likewise, CCE programmes' habitus, including the YCO_2 programme, holds that individual or collective action can mitigate climate change. Students whose value systems and habitus do not coincide with their educational institutions/programmes are less likely to embody the associated CCE-related habitus; thus their response may instead defer to governmental structures to act to combat climate change. The Flight-State theme offers a bridging opportunity for CCE programmes to address this conflict and enable diverse learners to adjust their habitus to encompass more individual agency.

3.2.4. Fight-Individual (Dominant)

Fight-Individual IDNs show active engagement with CCE generally, and the YCO_2 project specifically. 'No coffee 4 tomorrow' by goulow09 discusses causes of climate change:

> [The beginning] The year is 2030. The world is failing to produce sustainable energy and everything is getting worse. It will only be a few years untill the extinction of mankind is inevitable.

'Planet niobi' by tydand06 shows the impact of individual's actions on climate change:

> [Stop them?] well done, they listened to you, they parked their cars and began to walk. you are doing well so far, you have already improved the amount of carbon dioxide in the atmosphere

Thematically, Fight-Individual IDNs comprised the highest proportion of IDNs at Valley School. This suggests that most Valley students effectively engaged with YCO_2: they demonstrate understanding that climate change is an urgent problem needing resolution and belief their own actions can mitigate climate change. This demonstration of heightened individual agency suggests these students embody a habitus facilitating meaningful engagement with school discourse and wider structural discourse promoting action to combat climate change.

Valley School's affluent and academically successful nature suggests that the values within the school community align with those of white, middle-class hegemonic groups [31,49]; likewise, these groups and their habitus are commonly linked to climate change education and action [9,19]. Therefore, the school and its students likely hold a value system and embody habitus where CCE and action are valued, and climate change is viewed as an urgent matter requiring action. As such, there is less likelihood of a dialectical confrontation resulting from a habitus clash between student and CCE programme. Where familial and educational habitus aligned, students could embody the 'appropriate' habitus for their school setting [27], engage with the YCO_2 project topic matter and values, embodying them and reproducing them in their IDNs.

3.2.5. Fight-State (Bridging)

Fight-State responses demonstrate a shift in student understanding of governmental structures' role in mitigating climate change. The student has bridged the gap between their own habitus and the CCE habitus, enabling them to embody the new habitus [32] in which government engagement is a possible step. 'Sean's Kingdom' by peagua09 demonstrates a role for government:

> After the breakfast the delegation all attended to the Great hall for the meeting of reduce the pollution of having the war.

It is important to note that, like Flight-State, Fight-State only arose in one story. While the IDN's main focus of agency is governmental, the text also suggests a potential role for individuals and their actions in addressing climate change:

> I would like to invite my people to the castle to have a lovely dinner and talk about the issuses of the country with them so try to get some opinion.

Congruent with Laidley's work [19], Fight-State responses highlight student understanding of the importance of governmental action to combat climate change. This type

of response also suggests that the student can reconcile clashes between their home and school/programme habitus, so they can fully engage with CCE. The lack of individual agency shown in the IDN, however, indicates that the student does not embody a habitus where individual and governmental action act to counter climate change; they still have room to progress to full engagement with and embodiment of the YCO_2 programme's habitus.

3.2.6. Fight-Holistic (Dominant)

Fight-Holistic IDNs demonstrate a good understanding of CCE, active engagement with the YCO_2 project, and understanding that climate change can be countered through both governmental and individual action. The writers of this type of IDN understand, like Whitmarsh and O'Neill [14], that individuals' actions to counter climate change may be facilitated or impeded depending on governmental responses to climate change.

'CO_2 by coemai01 illustrates the effects of individual action:

> I spent days doing research and I made lots of changes to my life. I'm now vegan and don't use any plastic, I save water and food when I can and use renewable energy.

'Adventure of Anne' by walyin24 evidenced global, governmental-level mitigation:

> [Beginning] You are the president of the European Commision, you talk about the dangers of climate change and global warming.

Several Valley School IDNs expressed Fight-Holistic responses, showing awareness of the roles of both individuals and governments to mitigate climate change. This holistic approach suggests that their embodied habitus aligned with the school/programme habitus, which has expectations of engagement with wider institutions, access to decision-making processes and positive interactions with all members of the community [46]. Thus, the students embody a habitus that facilitates interaction with institutions. Valley School expectations are highly graded by Estyn, which suggests that the school does construct, embody and reconstruct middle-class values in line with both Bourdieu [27,31] and Tomlinson [49]. Where middle-class values are embodied within the school culture and values, and a large proportion of the student body is from a white, middle-class background, our data suggest that topic matters such as CCE is well received and students can engage with it readily, as it is culturally familiar.

3.3. Implications and Recommendations Based on Findings

The qualitative analysis of student-submitted IDNs on the YCO_2 project offers unique insights into the relative success and failures of CCE programmes. These insights can be situated within the sociological parameters of specific institutions as well as specific individuals to address barriers to engagement with CCE, and encourage students to engage in more positive attitudes regarding their power to mitigate climate change. In this section we present the implications of these findings, and how they can be applied to future CCE programmes in order to make improvements for greater programme efficacy.

3.3.1. A Holistic Agentic Climate-Change Engagement Model

The six categories of student responses in their climate change-centred IDNs as described in the previous section can be mapped against three axial continua representing student attitudes and perspectives regarding climate change, drawn from Bourdieu and mapped (below) to the Bicycle Model:

- Agency: student's sense of their own individual agency versus expectations of institutional (i.e., government) agency. This incorporates understanding of self-efficacy [4] and government/collective response efficacy [25] in combatting climate change.
- Power: student's view of their potential to engage with government to affect climate change. This connects to their capacity to embody dominant habitus and their alignment with hegemonic value systems [27].

- Engagement: student's level of engagement with the CCE programme as connected to the social context within which the YCO$_2$ programme is delivered.

Figure 1 illustrates each response category mapped against these attitudes. Attitudes and engagement are fluid, and definitively mapping any given expression of them to particular habitus, economic classes, or norms is not the aim of qualitative analyses such as ours. Rather, we position the student IDNs as indicative snapshots enabling us to estimate the range of potential responses to CCE in general, and YCO$_2$ specifically. As such, we have used a tri-axial continuum to visually indicate the relationships between the different types of student responses, engagement, and action within their various IDNs, in order to provide a springboard to identify and bridge gaps between CCE programmes and learner engagement.
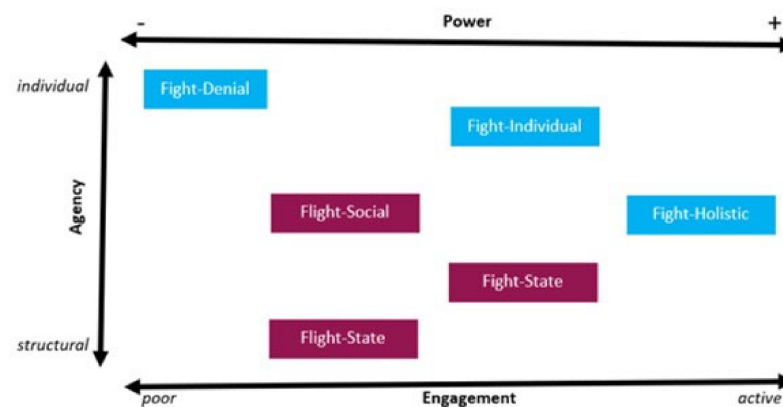
Figure 1. The categories of student responses mapped against three axial continua representing student attitudes and perspectives regarding climate change.

The arrangement of responses represents a progression from poor engagement in the CCE programme (with little expectation of effecting change) (Fight-Denial) to active engagement and a strong measure of power to combine personal and structural efforts to resolve the climate crisis (Fight-Holistic). This echoes work by Bostrom et al. [25]. They argue that individuals' views of their own capacity to mitigate climate change, and the efficacy of government or collective actions in mitigating it, are linked to individuals' concern over climate change. As they succinctly write (p. 818), 'policy support [to mitigate climate change] increases directly with increases in government collective response efficacy, as well as with increases in personal-self efficacy'. Thus Figure 1 shows increased power to enact change as linked to active engagement with climate change. Locating the Fight-Holistic response centrally between individual and structural agency highlights the connection between an individual's understanding of their own self-efficacy and the importance of perceptible governmental action to combat climate change [4].

Figure 1 illustrates the stages that our theorised students pass through as they move towards holistic and active engagement with climate change action; the YCO$_2$ project's aim is to support learners towards full, active engagement involving both individuals and structural institutions as shown in student IDNs incorporating Fight-Holistic themes. As described in the previous section, however, most of the student-submitted IDNs fell short of this holistic engagement. Thus, we identify a need to understand how learners move from one stage to another, in order to uncover barriers to engagement and accommodate them in future CCE programmes.

Combining the coded themes identified in this study's qualitative analysis and Cantell et al.'s Bicycle Model for CCE [8] presents a practical, tangible understanding of the different stages of CCE and the elements that facilitate student transitions from one stage to another. The stages represent milestones of didactic development that can be identified in student work, from Fight-Denial to Fight-Holistic. The pathway the learner travels between the stages represents the Bicycle Model's tools that enable educators to adjust the

CCE programme elements to the particular needs of the student and/or student group. Incorporating the Bicycle Model offers CCE educators programme elements that are within their remit to change/modify, such as hope and emotions (the lamp), motivation and participation (the saddle) and operational barriers (the brakes). Together, these form the framework of our 'holistic Agentic Climate-Change Engagement' model (h-ACE), illustrated in Figure 2.
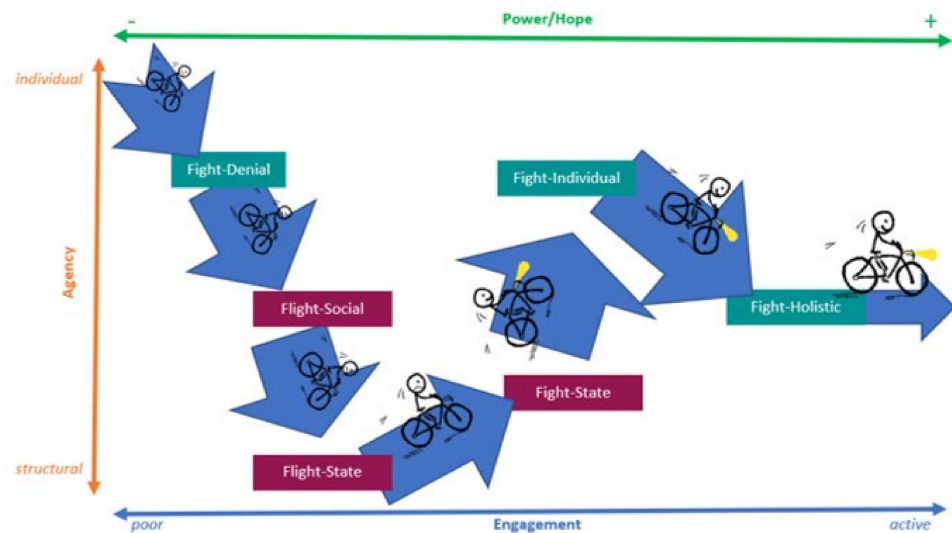
Figure 2. The 'holistic Agentic Climate-Change Engagement' model (h-ACE model).

Key elements of the Bicycle Model map to the Bourdieusien framework, aiding climate change educators in identifying gaps in their CCE programmes, and how to bridge them. The Bicycle Model's frame (the learner's identity, values, and worldview) represents their habitus from a Bourdieusien perspective. Designing a CCE programme founded in the learner's frame/habitus shapes the message so that they are better able to accommodate the new knowledge (wheels). New knowledge applicable to their own habitus enables learners to situate their values within the context of climate change, and this deeper understanding enables agency: if the learner perceives that they hold power (pedals/chain) to act (saddle) to oppose climate change, they will have hope (lamp) for a future shaped by their own actions. Thus the three axes of Figures 1 and 2 enable tracing students' progression through the learning pathways from resistance to activism, as knowledge and engagement increase agency and power, leading to increasing hope based on one's own actions.

The h-ACE model provides a contextualised, theoretical understanding of the identity, values and world view (frame) underpinning students' experiences and value systems. Awareness of these values and frameworks enables CCE educators to engage with their students' habitus. In turn, this heightened awareness enables teachers to support their students through any dialectical confrontations [32] that occur as a result of exposure to and potential embodiment of a new habitus regarding climate change. CCE educators can review their students' work, place them along the pathway from rejection of CCE (Fight-Denial) to the gold-standard of holistic engagement within the model (Fight-Holistic), and identify gaps between the CCE programme's habitus and the students'; targeted bridging efforts can then be made to better reach the students. This programme has the capacity to support young people to become 'carbon capable actors' who 'understand the impacts of daily activities on climate, while also being aware of, and seeking to influence . . . societal structures . . . to overcome the system level barriers to low-carbon lifestyles and societies' [14] (p. 8). Utilising CCE programmes that incorporate the H-ACE MODEL empowers students to transition to a habitus in which climate change action holds value [9] and move towards a paradigm in which action is possible and desirable [22].

3.3.2. Practical Implications of the H-ACE MODEL

The H-ACE MODEL provides insight to the journey that learners take along the pathway from lack of knowledge and engagement with CCE to full knowledge and engagement. It is important to note that there may be barriers to full engagement linked to educational need or habitus clash between home/school setting. Careful consideration of the type of response and its location on the H-ACE MODEL can help professionals ascertain the steps required to support learners from one stage along the journey to the next, towards full and active engagement with CCE. This support can ideally empower students to break from Dominant responses to CCE (such as Fight-Denial) and engage fully with the topic.

For learners with additional education needs (ALN), CCE practitioners must clearly differentiate materials in order to make the curriculum more inclusive. For example, the high number of incomplete IDNs submitted on the YCO$_2$ programme suggests that students had insufficient time for the tasks assigned. Students with ALN may benefit from pedagogical resources to help them access tasks appropriately [51,52], including

- Mini-whiteboards for planning;
- Time to talk through plans of stories with peers and/or adults;
- Use of spell checkers for students with 'English as an Additional Language' and those with spelling difficulties;
- Extra time to write stories;
- Writing frames to support those with weak working memory, literacy difficulties and social/communication difficulties.

In terms of sociological barriers to engagement, students may experience a dialectic confrontation as the CCE programme presents a new and unfamiliar habitus. CCE educators should take care to ensure that any programme of study allows for engagement at the local level [9,18], where actions are tangible, perceived as feasible and sit within the value system (habitus) embodied by those students. Once they have then embodied a habitus that engages with climate change at a 'lower' level, where individual action is possible, the programme can introduce participants to a habitus whereby engagement at wider levels is tangible and feasible, and the habitus accessible. This can be achieved through careful selection of activities, programme leaders, and topic content [21].

4. Conclusions: Transitioning You and CO$_2$ from Trial to Holistic CCE Programme

The YCO$_2$ project aims to empower young people to act to combat climate change, both at individual and governmental levels. In this, its first iteration, we based its design primarily on the New Curriculum for Wales [7], using the three workshops and student reading and writing of IDNs to encourage students to (1) commit to a sustainable planet, (2) understand and exercise their individual and structural agency, and (3) understand and consider the impact of their choices and actions. The initial design of the YCO$_2$ programme embodies and propagates a value-system where climate change is an urgent problem requiring action; as noted above, numerous factors contribute to this value-system most often aligning with the middle class [7,9,19,31,49], which may conflict with the habitus of those who are not white and middle class.

The student-submitted IDNs reflected the students' educational contexts. Valley School students were generally positively engaged with CCE and had a positive view of individuals' ability to mitigate climate change. This reflects the school culture as a high-performing school, embodying the hegemonic middle-class habitus and value system. A large proportion of responses also engaged at government level, which mirrors the school ethos, where students' access to 'power' within the school is encouraged. We theorise that where students' values did not align with the white, middle-class values from which their curricula and the YCO$_2$ programme originate, a larger proportion of their IDNs displayed denial and disengagement. To draw robust conclusions, however, further research is needed. This aligns with Laidley's view that engagement and action on climate change is significantly affected by social class and culture [19]; this appeared to be the case at Heighton School.

Although Hughes and Paterson [53] describe barriers to engagement at international level and relate them to career-academics, the notion of needing to be male and/or from wealthy nations in order to make positive strides in engagement with climate change may resonate with some students. That is to say, where students are from countries whose participation in the IPCC is structurally impeded, there may also be barriers to individuals' engagement with climate change mitigation. Given the high number of students at Heighton for whom English is an 'Additional Language', it may be that these students' dialectical confrontation was not that of a clash between middle- and working-class values, but rather between white, UK-based, middle-class values and those of the international students' home nations. We must not discount, however, the effect that working in an additional language may have on their ability to express themselves and fully engage. As such, further work is needed to explore the responses of working-class students to CCE programmes such as the YCO_2 project. That said, the H-ACE MODEL can help teachers and educators understand how to plan lessons or programmes of study so that such cultural- and values-based barriers can be minimised.

As noted in the Methodology section, the YCO_2 programme delivery differed significantly between Valley and Heighton Schools in terms of length of the workshops, time between workshop deliveries, and pedagogical approaches to Workshop 1. These differences in programme delivery mean that any conclusions drawn from their data must be clarified through further work, in different settings but with consistent delivery. Similarly, the high proportion of incomplete IDNs indicates a structural inadequacy with the first iteration of the programme: insufficient time. Students were not given enough time to complete their IDNs; likewise, for those with ALN, the material is not yet adequately differentiated to meet their needs. Further work with teachers and other professionals is necessary to improve this for future delivery of the programme.

It is also important to note that this initial iteration of YCO_2 did not collect demographic data from the students, so it is not possible to make robust, secure claims regarding the individual students' familial habitus and how these are reflected in their IDN responses; our analysis is therefore speculative and based solely on general demographic data from the schools and the qualitative coding, within the contextualisation of existing CCE literature that establishes CCE largely within the specific habitus of the middle class. Arguments could be made that it is not learner habitus misalignment with the hegemonic habitus of middle-class values in British education, but with some other, as yet untheorized habitus influencing climate change messages. Nonetheless, as the dominant habitus in both school settings and programme designer settings matches that noted in the CCE literature (white, middle class), we have used this as the logical 'default' habitus from which non-engaging learners are most likely to deviate from.

In order to more thoroughly map the misalignment between CCE programme habitus and learner habitus, future instances of the YCO_2 CCE programme must and will collect the relevant demographic data and map them against individual IDNs. Likewise, implementing YCO_2 in a spectrum of schools with varying demographics in terms of economic class and cultural background will offer deeper insights into the role of habitus with CCE engagement. Each of the schools in this study had a significant proportion of students from white, affluent backgrounds, which does not give deep insight into the experiences of other demographics.

Revisions to the YCO_2 CCE programme will thus mitigate these limitations. Changes will be incorporated to increase programme accessibility for students with additional learning needs, and students where English is an additional language. These may include additional optional 'modules' for teachers to implement on an as-needed basis, such as extra time within and between workshops, IDN planning exercises, and templates for constructing their IDNs. The workshop design will be modified so that the introduction and promotion of its CCE value system does not act to constrain and actively oppress those whose value system and habitus does not or cannot incorporate the 'new' YCO_2 habitus. Failing to reconcile these potential dialectic confrontations risks alienating those

students whose values do not align with the 'accepted' middle-class values, leading to the formation of 'subgroups' who refuse to engage with climate change at all. This may include localisation of the curriculum, to better reflect the students' local environment, familial habitus, and knowledge structures. For increased robustness of the data set, demographic data will be collected in order to draw a clearer picture of individuals' specific habitus, and how these are reflected in their IDNs.

The YCO_2 CCE programme is already a unique and engaging approach to CCE, demonstrated by the positive responses to it from educators and students, and the various institutions that have sought to incorporate it in their curricula. The study outlined here illustrates its current limitations and offers a clear and concrete path to improve the programme for deeper engagement and more thorough efficacy. YCO_2's foundation is strong, based as it is on the New Curriculum for Wales; with the developments outlined here, it can become an even more positive and powerful model to engage young people in the fight to battle catastrophic climate change.

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