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# Transforming education for the just transition

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Original research article

# Transforming education for the just transition☆

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ABSTRACT

Society faces many challenges in promoting a *just transition* to a low-carbon economy, a transition that does not create or exacerbate injustices. Notably, the just transition can only be attained with new educational approaches which revolve around social, climate and environmental justice. This paper advances that for a just transition, the shift to a greener economy cannot be driven by the traditional neoliberal engine, which has captured educational practices. Rather, the necessary educational transformation needs the principles of critical pedagogy and the dimensions of justice provided by the JUST Framework. We bring these two important schools together and draw on the experience of the global periphery and Latin America in particular, to develop a unique theoretical framework that contributes to the literature on education for sustainable development. Therefore, this conceptual research provides a theoretical framework that should guide education for a just transition. This paper establishes what is referred to as CCR Education Framework which involves: *Critical thinking* about climate, environmental and social costs of fossil fuels; *Coexistence* with nature and the other; and *Resistance* against neoliberalism and other forces that jeopardise the just transition. The CCR Education Framework is a response to the question of what education needs to include to achieve a just transition. The paper also opens the discussion about the implications of the Framework in terms of teacher training and education and appropriate pedagogical approaches. The key theoretical advancements here is that education for the just transition must affirm the importance of teachers and students as agents of transformation, and promote critical educational practices and approaches which support the transition to a low-carbon economy, and which value the characteristics of justice (which include equity, equality, fairness, and inclusiveness) to build a curriculum that advocates sustainable growth and a societal just transition.

## 1. Introduction

In this article, it is advanced that education has a transformative role to play in promoting a *just transition* to a low-carbon economy. Education needs reform whether it is in formal and informal settings, or from school education to community-based and civil society initiatives. Education provides the individual and society with the tools necessary to understand the urgent need for the profound change by the energy sector to enable the world to transition to a green and sustainable economy [1,2]. A partial transition will not be sufficient and hence the importance of global collective action on transforming education.

The energy sector is responsible for the high levels of greenhouse gas (GHG) emissions that contribute to climate change. These impact all our daily lives as we go about cooling or heating our homes to eating our food, moving our vehicles and powering our phones [3]. Therefore, the move away from fossil fuels towards renewables is urgently needed to tackle climate change. In addition, the energy sector is responsible for causing historical injustices, such as: environmental pollution and human rights abuses caused by the extractives industry for coal, oil and gas operations in lands occupied by traditional and indigenous

communities [4]; and authoritarian regimes benefiting from oil and gas to tighten their rule and increase repression [5,6]. Further and more recent injustices include: the political and economic abandonment of whole communities who once prospered from mining [7]; employment of forced labour in the production of solar panels [8] and batteries [9]; wind farms that threaten endangered species of birds [10]; and climate debt and also loss and damage, which was the subject of much debate at the recent United Nations (UN) COP27 discussions [2].

These are only some examples that dramatically show that we need to ensure that the transition to a low-carbon economy is *just*. Essentially, a just transition demands that governments, businesses, and individuals have respect for the environment and for human rights. From this perspective, education must provide the individual with lifelong learning opportunities to acquire the knowledge and skills necessary to change their own behaviour, to transform themselves [11,12]. First, students need to be educated to become consumers (and prosumers) of energy who are aware of the costs associated with the choice between low-carbon and fossil fuel energy sources. Second, individuals and communities need the education to enable them to participate as producers, workers, or businesspeople in the new renewable energy market that, as we explain below, progressively reduces and replaces the fossil fuel sector. Third, education needs to enable the individual and community to demand changes from economic and political actors. In summary, education must facilitate students to become actors of change – social actors able to act individually and collectively to tackle climate change and provide solutions. For example, education would be responding to the engagement with climate action that students across the globe are showing today [13].

A key recent example shows how individuals and society can impose a change in business practices on major energy companies and strengthen the transition to a low-carbon economy. This occurred with *Milieudefensie*, a Dutch climate organisation who, acting independently and on behalf of over 17,000 Dutch citizens, succeeded in having the District Court in The Hague order Shell to cut its carbon emissions [14,15]. This case shows that individuals with the necessary knowledge and skills can change the business practices and corporate strategy of a multinational energy company. Education is crucial therefore in building knowledge and skills necessary for a just transition.

To this end, this paper calls for an education aligned with the principles of just transition to promote a new vision of the education system and its interrelated dynamics. The objective is to assist individuals and society to resist the forces of the *status quo* that jeopardise the transition, and to build a new world of low-carbon emissions and lower levels of injustice. This article is conceptual and advances a theoretical framework that is intended to close a gap in the literature. The objective is to provide a framework that helps in formal and informal education environments across the globe. Our examples include the shortcomings in the current education models that are dominated by the neoliberal machine. An overall educational transformation is needed and this is further highlighted by the journal Nature, wherein one study describes how students remain subjugated by existing educational practises that perpetuate the fossil fuel industry [16] and another calls for the application of the United Nations Sustainable Development Goals (SDGs) to foster the "decarbonization of pedagogy" [17].[1]

Therefore, we advance the CCR Education Framework which comprises three central facets: (1) *C*ritical thinking about the climate, environmental and social costs of fossil fuels; (2) *C*oexistence with nature and the other, and (3) *R*esistance against neoliberalism and other

forces that jeopardise the transition. The CCR Education Framework draws on two well-established frameworks that have yet to be combined in a single theory: the JUST Framework and the Freirean pedagogy. The JUST Framework, which has been articulated by Heffron and McCauley [18] and later developed with and by other academics [19–22], clarifies what "just transition" means in practical terms: it encapsulates different dimensions of justice (recognition, distributive, procedural, restorative, cosmopolitan) into one framework and sets the grounds for the realisation of justice in practice [23].

While the JUST Framework is extremely useful to begin an articulation of a pedagogy of a just transition because it helps identifying energy injustices, it is insufficient to complete this articulation, as it requires an interdisciplinary dialogue with the relevant education literature. Therefore, this is where the addition of Freirean school which has been addressing the manifestations in education of the many injustices that the JUST Framework identifies is highly valuable – in particular, in the past it has been used in learning about injustices created by the lack of recognition and cosmopolitan justice. In fact, the Freirean school of education [24–27], with particular emphasis on the rejection of banking education and the promotion of a dialogue of harmony with justice and well-being (with nature, with the other), allows for all the dimensions of the JUST Framework to be realised in terms of a true education for the just transition.

In the next Section 2, we explain the research design and the organisation of the paper.

## 2. Research design

We make a conceptual contribution to the literature by developing a theoretical framework to support educational practices for just transition, with emphasis on the global periphery and Latin American experience. So placed, the emphasis directs the selection of the injustices – human rights violations and inequality, pollution, colonisation – and challenges – neoliberal education – that are subject of analysis, among the many problems that an education for just transition faces.

Our paper is in dialogue with different literatures but more closely with the education for sustainable development (ESD) literature. This is because ESD is concerned with all fundamental problems that are subject of this analysis. However, what the ESD literature lacks is a clear articulation of the need to ensure justice in the transition to a low carbon economy. The UNESCO reports on ESD [28–32] target the change in individual and collective behaviour to enable energy transitions, and put forward different learning objectives (see Table 1 below).

There are suggested different topics of discussion and examples of activities, some of which are important to the present context [28]. However, we notice that *ensuring justice in the transition* emerges very weakly in the learning objectives (we emphasised what is more relevant). Also, we notice a general lack of concern about the serious risks that the transition to a low-carbon economy poses to the attainment of the other SDGs. When we contrast this with the significant interdisciplinary literature on just transition [33], we realise the lack of a clear articulation of the need to ensure justice in the transition in education.

Beyond the UNESCO reports, the ESD literature that directly addresses energy transition is extremely incipient, as we can see in a recent bibliometric review [34]. A search on Scopus and Web of Science confirms this: a search for "education for sustainable development" and "energy transition" returned 4 results; for "education for sustainable development" and "energy justice" and for "education for sustainable development" and "just transition" obtained no relevant results (January 2023). Within the articles obtained in the first group, relevant papers tend to emphasise consumption and change in behaviour at the local level, for instance [35,36].

The concern about how the transition to renewables, in other words, how the change in behaviour towards renewable energy, may aggravate economic inequality, may be unjust, is absent in the literature. An example helps understand this point: Lennon [37] describes the case in

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[1] Very slowly, universities are beginning to implement changes in the curriculum and promote a reflection of educational practices, for instance, with the establishment of an MSc in Energy Ethics at the University of St Andrews, of a Lectureship in Law and Just Transition at the University of Glasgow, and of the Just Transition Hub whose scope includes the promotion of research on education for a just transition at the University of Dundee.

**Table 1**

Learning objectives for SDG 7 "Affordable and Clean Energy" – Source: [28] (emphasis added).

| Cognitive learning objectives | 1. The learner knows about different energy resources – renewable and non-renewable and their respective advantages and disadvantages including environmental impacts, health issues, usage, safety and energy security, and their share in the energy mix at the local, national and global level.<br>2. The learner knows what energy is primarily used for in different regions of the world.<br>3. The learner understands the concept of energy efficiency and sufficiency and knows socio-technical strategies and policies to achieve efficiency and sufficiency.<br>4. The learner understands how policies can influence the development of energy production, supply, demand and usage.<br>**5. The learner knows about harmful impacts of unsustainable energy production, understands how renewable energy technologies can help to drive sustainable development and understands the need for new and innovative technologies and especially technology transfer in collaborations between countries.** |
|---|---|
| Socio-emotional learning objectives | 1. The learner is able to communicate the need for energy efficiency and sufficiency.<br>**2. The learner is able to assess and understand the need for affordable, reliable, sustainable and clean energy of other people/other countries or regions**.<br>3. The learner is able to cooperate and collaborate with others to transfer and adapt energy technologies to different contexts and to share energy best practices of their communities.<br>**4. The learner is able to clarify personal norms and values related to energy production and usage as well as to reflect and evaluate their own energy usage in terms of efficiency and sufficiency**.<br>**5. The learner is able to develop a vision of a reliable, sustainable energy production, supply and usage in their country.** |
| Behavioural learning objectives | 1. The learner is able to apply and evaluate measures in order to increase energy efficiency and sufficiency in their personal sphere and to increase the share of renewable energy in their local energy mix.<br>**2. The learner is able to apply basic principles to determine the most appropriate renewable energy strategy in a given situation.**<br>**3. The learner is able to analyse the impact and long-term effects of big energy projects (e.g. constructing an off-shore wind park) and energy related policies on different stakeholder groups (including nature).**<br>4. The learner is able to influence public policies related to energy production, supply and usage.<br>5. The learner is able to compare and assess different business models and their suitability for different energy solutions and to influence energy suppliers to produce safe, reliable and sustainable energy. |

which community members become interested in solar energy because of the Solarize campaign (which is a positive change in behaviour), but that the pragmatism of the campaign led community members to fixate on the price, without much regard to the social and environmental costs associated with the production of solar panels. The CCR Education Framework begins to close this gap by clearly articulating an education framework that is concerned with the need to ensure justice in the transition to a low-carbon economy.

Henceforth, the paper evolves in four main parts, with the argument organized in the format of problem-answer (sections 3 and 4–5), problem-answer (6 and 7–8).

*First*, in section three, we define the problems that education for the just transition must address to bring about transformation. The definition of the issues is informed by a global periphery and Latin American view and emphasises human rights, inequality, pollution and decolonisation in the context of the transition. The literature review here is not exhaustive but serves to situate the issues within the context of the transition. Again, the paper is conceptual, and its objective is to promote a deeper debate on the topic.

*Second*, to address these issues, we bring together JUST Framework (section four) and critical education (section five), the latter through a Freirean perspective. With the JUST Framework, we emphasise the need to advance the different dimensions of justice and note the relevance of human rights and environmental law to enable this advancement. Because of the perspective that we adopt, two dimensions of justice become particularly important – recognition and cosmopolitanism. With critical pedagogy, we emphasise critical thinking, coexistence and the hope for a different future, and the building of skills necessary for the individual to be an agent of transformation. To strengthen critical thinking, we call for knowledge of international human rights and environmental law, because this law creates obligations on states. Knowledge about these two branches of international law helps the individual acquire a new view of recognition justice, by understanding their own rights and the obligations that fall on their respective states. This knowledge also fosters cosmopolitanism as the same international law applies in different states. We leave aside the details on the states that are parties of the treaties and so bound by them.

*Third*, with the contours of what education for just transition should

encompass, we define another problem in section six, neoliberal education, which is mainstream across much of the globe. The challenge now is to understand how neoliberal education jeopardises an education for a just transition. *Fourth*, the discussion about neoliberal education enables us to articulate the CCR Education Framework in section seven with a reflection about teacher training and education, and about different pedagogies. Finally, in section eight, we close our argument.

## 3. Promoting a just transition: a transformation challenge for education

### 3.1. Introduction

To understand what ensuring a just transition requires from us, we need to understand the impact of the energy sector in our lives. Only from this perspective can we grasp the complexity and depth of the challenge of reforming the energy sector and the types of knowledge and skills required from extant and new generations. In this section, we highlight cases of energy injustice, which energy transitions may aggravate and these include: global economic inequality; disparities in the labour force; socio-economic injustices; climate and environmental injustices; and decolonisation. It should be acknowledged that energy has enabled economic growth in many countries, but the question is at what cost. Further, the question is whether fossil fuels sector has prevented low-carbon energy from growing and performing the same functions fossil fuels perform but without all the damaging costs.

### 3.2. Energy and global economic inequality

The energy sector is crucial to our daily lives. In economic terms, it accounts for a significant part of the global economy. In 2021, global investment in the energy sector reached US$1.9 trillion, and investment in clean energy reached US$750 billion [38]. But these volumes are far below the energy needs of the world and the requirements of a transition to a low-carbon economy [39]. Notably, energy and fuel poverty affect people in the least developed, developing and developed countries [40–42]. As of 2018, lack of electricity affects around 1.2 billion people worldwide and, of clean cooking fuels, 40 % of the people worldwide [43]. Women and vulnerable groups, especially in the least and developing countries, are disproportionally affected [42,44]. Events such as conflicts jeopardise gains in the reduction of energy poverty including in developed countries, as witnessed in Europe following the invasion of Ukraine by Russia [45], which causes rises in inequality.

Further, estimates of the amount necessary to transition to a green economy vary according to different scenarios – in a scenario of net-zero emissions by 2050, investment in clean energy needs to reach US$4 trillion annually by 2030 [46]. Again, there is a huge difference in terms of investment in energy and more particularly in renewables in the developed world in contrast with the developing world. A recent report by the International Energy Agency (IEA) [47] shows the existence of "a widening gap between advanced and emerging and developing economies […] the former dedicating ten times more fiscal resources to sustainable recovery measures than the latter". This suggests that unjust energy transitions may accentuate the inequality among regions.

Education can respond to this reality in different manners, notably through inclusion and, especially in developed countries, through cosmopolitanism (understanding the reality of other regions). The literature on these topics is growing [48–52], but we call the attention to the *manner* that both inclusion and cosmopolitanism can be implemented, either as instruments of oppression [53], or as instruments of freedom, solidarity and hope (Section 5 below).

### 3.3. Disparities in the labour force

There is significant inequality in terms of knowledge and skills of the workforce. If this continues unabated, it will aggravate inequality within

countries. Again, to place this in perspective, the energy sector is a major *employer* worldwide, employing 65 million people in 2019 (2 % of global employment).[2] Employment in the renewable energy sector is likely to continue increasing [54]. But this may further exacerbate inequality in the workforce. According to the IEA [54], around 60 % of new jobs in clean energy will "require some degree of post-secondary training" (p. 7). However, as Veronika Czako reports:

> The workforce in the energy industry, especially in conventional energy sectors is male dominated and is aging. Digital skills and graduates in Science, Technology, Engineering and Mathematics (STEM) fields are in high demand. Parallel to STEM profiles, *soft skills* including customer awareness, problem solving, team working, self-management, and communication and literacy are key employability skills in the energy sector. STEM education, especially Engineering and ICT studies are characterized by *gender imbalance*. This is an underlying factor of underrepresentation of women in the energy sector. ([55] p.4, emphasis added)

We note how, again, women are disproportionally affected which is corroborated by recent reports of the IEA [46], a point to which we return below. What Czako lists above are simply examples that suggest the need for different actions. It is evident that education must be inclusive and must provide the required training for the individual to enter the job market. What may be less obvious is what is hidden under "soft skills" – namely that education must also provide the knowledge and skills that enable the individual to change their own behaviour and demand changes in the behaviour of governments and businesses. We define the knowledge and skills as those necessary under the CCR Education Framework (Section 7).

### 3.4. Human rights violations and socio-economic inequalities

Linked to these issues, there are violations of human rights and socio-economic injustices. The energy sector is historically marked by high levels of violations and abuses of human rights as documented by the Business and Human Rights Resource Centre [56]. Consequently, the energy sector has contributed to high levels of inequality among peoples and regions across the world [57]. For instance, a recent report by Dejusticia and Business and Human Rights Resource Centre [58] finds, among other things, that "coal aggravates poverty locally – and may have little positive net economic effect nationally" (p. 46), that "human rights violations around the coal industry thrive in contexts of weak and/or repressive governance" and that "a just transition from coal is crucial" (p. 6).

The latter is evident from South Africa who relies heavily on coal and sees rolling blackouts due to poor policy decisions and governance. Moreover, inappropriate policies may result in poor households [59] and whole regions paying an undue amount of the socio-economic and environmental costs associated with the transition to renewables. These are examples only and, while socio-economic injustices are multiple, we place focus on gender and race as exemplars of social justice.

The existing unequal gender structures in society, which increase the vulnerability of women to the impacts of climate change [60–65], also make gender a driver of energy inequality [66,67]. Not only the burden of energy poverty [68], but also the burden of unjust energy transitions affect women disproportionately [69]. Gender inequalities must be understood in relationship with other factors such as socioeconomic status, race, ethnicity, place of origin, sexual orientation and age [61,70–76]. Pulido [77] argues that concepts of "race" and "class" are often insufficient to illuminate the many ways in which racism can be used to expand power, profits and injustices. Power injustice involves intricately

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[2] Distributed in fuel supply (21 million), power sector (20 million) and end users (24 million).

overlapping or marginal layers [78]. Structural and systemic inequalities cause the marginalisation of the voices, experiences and rights of women, black, indigenous, and other minority groups [66]. So combined, inequalities and marginalisation exacerbate injustices in terms of energy access and use (the distributive dimension of justice), and in terms of representation in the workforce and decision-making (recognition and procedural justice).

Education is crucial in addressing this latter need, for example, by integrating a gender perspective into curricula, educators can promote "values and practices of inclusivity and diversity and advance SDG 7 in a tangible way" ([79], p. 1). But, again, this needs to be clearly done also in the context of the transition to a low-carbon economy, with awareness that the transition may exacerbate gender and other social-economic inequalities. Although the ESD literature is concerned with addressing inequality, for instance [28], clear links with the energy transition are lacking. CCR Education Framework makes these links, notably through recognition justice and the pedagogy of the oppressed. The varied dimensions of the energy transition cannot be analysed, and cannot be brought to education, without considering the perspectives of marginalised groups. Therefore, rather than objects of research and policy intervention, marginalised groups need to be recognised and enabled as agents of change in recognition of their own socio-cultural and knowledge systems. Education for a just transition must therefore promote both recognition and agency.

### 3.5. Climate and environmental injustices

The energy sector is responsible for three-quarters of the total GHG emissions that cause global warming [46,80]. As a recent IPCC report [80] shows, transition from fossil fuels to renewables is urgent. Therefore, it is urgent that educational transformation begins and prepares all stakeholders for the just transition. As exemplified above, the energy sector is also historically responsible for *environmental degradation* and therefore climate debt. Awareness of the need to protect the environment across the globe, and the realisation of the links between environmental degradation and climate change are needed. Further, the comprehension of the temporal and transboundary effects of economic activities linked to the energy sector – for example, understanding what an environmental impact assessment (EIA) is and how it helps avoid the destruction of the environment are all important for the individual to act in the promotion of a just transition. To become a reality, a new "green economy" depends on the individual's and society's *awareness* of the problems caused by the energy sector and their *ability* to move away from fossil fuels to low-carbon energy sources and technologies [81,82].

For its importance, we expound on this point. Education may either alleviate or cement climate and environmental injustices. At least since the 1960s, environmental issues have been addressed in an education and sustainability context with increasing frequency by academics and in UN World Summits and Conferences [83]. The topics discussed ranged from the deterioration of the physical environment, education for a sustainable future, "deforestation, climate change, wars, famines", and the rights of human beings to live "a healthy and productive life in harmony with nature" ([83], p. 3). Since then, the literature on environmental education has made extensive progress on developing pedagogies to raise awareness and promote action on these issues [84–87].

However, there remains a growing concern about educating students about risk reduction and about developing resilience skills [83,88,89] – that is, the potential for people and societies "to face existential risks and resist or recover from the adverse effects of a crisis" ([83], p. 4). Sadly, school curricula, for instance in England [90] and in other countries [83,91] do *not* seem to respond to those calls to educate *for* the environment and *for* social justice. Instead, environmental education has remained largely education *about* the environment [90].

It seems that governments and the fossil fuel industry work to counter and inhibit new thinking in education where education concerns environmental protection, human rights, socio-economic values, and

justice – and this has been the direct experience of some of the authors. Indeed, one of the greatest challenges to enact new pedagogies in environmental education is the deliberate and intentional actions of the fossil fuel industry to obstruct critical pedagogies that otherwise could address issues of power and manipulation [91,92]. Recent reports throw light on the close relationship between universities, academics and the fossil fuel industry [93], who has been influencing the teaching [94] and funding the research, including on climate change and energy transition [95]. Further, Gruenewald [96] has argued that the institutionalization of environmental education in mainstream schooling has reinforced complacent positions from teachers, instead of addressing socioeconomic and political problems of ecological problems – and evident in both western and non-western nations. Eaton and Day [91] have shown concerns about how to educate for a just transition, however they have not fully developed this argument.

Finally, it is critical that we address the issue of just transition by challenging the individualistic mentality advocated by neoliberal agendas, present in schools. Paraphrasing Gadotti [97], a pedagogy for a just transition must have the Earth as its fundamental and central point to promote a new model of civilization that is ecologically sustainable. We will develop this argument later in this article, notably under the *Resistance* pillar of our framework.

### 3.6. Decolonisation

Finally, there is the issue of decolonisation. Writing on settler colonialism, Tuck and Yang [98] denounce what they see as the metaphorization of decolonisation: the true purpose of decolonisation arguably being the return of the "stolen land", the discourse about decolonisation in education becomes a metaphor to address social injustices. Our view of decolonisation is informed by the Latin American experience, in contrast with the "decolonial bandwagon" [99]. Our view is broader than what Tuck and Yang [98] propose, as it draws on the work of Santos [100] on "ecology of knowledge" in line with Fernandes et al. [101] who bring Santos' theory to the study of the peripheries.

We acknowledge the existence of what are referred to as abyssal lines [100] inherited from colonialism which create divides where dominant forms of thinking and living belittle peripheral cultures and lives, and create barriers that jeopardise dialogue and learning. We argue that the incessant reproduction of these colonial lines, by local governments and elites that replaced the old colonies [57,102], became entangled with neoliberalism, environmental racism, racial capitalism etc. and contributed to environmental and social injustices, especially in the energy sector.

This is evident, for example whereby the Brazilian government adopted a colonial attitude towards indigenous peoples, to justify the illegal occupation of their lands by miners [102]. Likewise, social-cultural processes may jeopardise the development impact of energy access projects [103]. So, more than "the result of the local state acting within the context of neoliberalism" in the poisoning in Flint ([77], p. 1]), the history of environmental and social injustices in the energy sector is also the result of the incessant reproduction of these colonial lines [104]. In a similar way we can think of coloniality of multinational corporations [105], notably in the fossil fuels sector, and the manner that coloniality materialises, for example, in their relationship with universities and academics, as discussed above.

Decolonisation is the deconstruction of these lines *with* and, notably, *by* the peripheries, who become agents of change in the construction of new forms of dialogue and action. A decolonial approach to the energy transition seeks the redefinition of human well-being in a planet-friendly way to enable "multi-epistemic" literacy and learning and dialogue between diverse political, ethical and epistemic positions [106]. Thus, a pedagogy for a just transition challenges this by incorporating what Santos called "ecology of knowledge", which is underpinned by the principle of mutual dialogue and learning to produce "alternative thinking of alternatives" [100].

Further, we need to move towards cognitive justice where epistemic diversity is captured. This is reflected under the Critical and Coexistence pillars of our framework where educational processes encourage students to critically approach their personal philosophies and judgements, and to reflect on their thought processes. However, like Bluwstein [107], we share Tuck and Yang's [98] fundamental concern that decolonisation entails action beyond academia and the classroom, this being the reason for our emphasising, under the Resistance pillar of our framework, the building of skills to enable the student to resist the forces of "fossil capitalism" [107].

Decolonisation cannot happen unless led by the peripheries. This is crucial to address the historical tensions imposed by the development agenda of central states, and economic agendas of big corporations. Walsh [108] emphasises that the "decolonial" is not a new condition to be processed, implemented or achieved by government. For Walsh [108], it is a fallacy that governments can realise decolonization without first radically transforming the very notions of authority and power. The decolonial, in this sense, is not a fixed state, status or condition, but it is a dynamic process. It is always under construction and reconfiguration given the permanence and reconfiguring capacity of the "coloniality of power" – its power to reproduce in different social settings, for example [57]. This process occurs within the education system and through education. For instance, reflecting on their engagement in research collaborations with Indigenous communities, Styres and Zinga [109] argue that the educational environment requires theoretical frameworks that "encourage collaborators to create ethical space where these assumptions can be explored and challenged, having implications for transformative practices".

### 3.7. Conclusion

We summarise the above with a call for the protection of human rights, especially of those who are marginalised and disproportionally affected by the economic activities connected to the energy sector in the transition to a low-carbon economy; and of the environment, notably ecosystems that are more vulnerable to such activities, in such context. We need to realise that violations of human rights and damage to the environment may occur along the energy life cycle (extraction, production, operation and supply, consumption, waste management and decommissioning) and for example, in a country far from the energy consumer. Again, awareness of the problem and the ability to act on this are crucial.

We can advance that a just transition requires both the tackling of historical injustices towards human beings and the environment and the prevention of new injustices. At a more fundamental level, we need to overcome the mindset underpinned by the neoliberal machine and its model of development [110,111] that marks the energy sector. It is precisely this mindset that perpetuates the reckless overexploitation of nature and marginalises the other. Moreover, as further discussed in Section 6, this mindset is near omnipresent in mainstream education.

### 4. The JUST Framework

In this section, we demonstrate that the concept of just transition is a powerful instrument to overcome the shortcomings of neoliberalism in education. We need a conceptual framework of just transition which, grounded in theory, addresses the injustices above, and paves the way for its application in education.

The JUST Framework brings environmental, climate and social justice together, ensuring a *holistic* approach to the topic, and it offers a pathway for its application in practice, which is important when bringing just transition to the classroom. We begin by drawing attention to the time and space of climate change, i.e., that the *world* must transition to a low-carbon economy *urgently*. A partial transition in isolated countries – irrespective of whether such countries are in the global centre or global periphery, to borrow Wallerstein's terminology [112] –

or a slow transition, especially in countries responsible for most of the emissions that cause global warming, will not be sufficient to tackle the effects of climate change. Thus, policies adopted to promote the just transition must be properly designed to respond to the urgency of the transition to a low-carbon economy, lest these policies may threaten energy and climate goals [113].

Hence, it is no longer appropriate to think, or to educate students to think, locally and without a sense of urgency. It is necessary to raise awareness of the space and time in which the transition must happen, and these are *the world* and *now*. But urgency must be emphasised in a manner that enables action, rather than triggering anxiety and defeatism. This leads us to highlight the importance of geography and human geography in the curriculum, to enable the individual to make links between economic activities and their environmental and social impact (including the UN SDGs) – and, as we explain in Section 7, to affirm that teaching and learning activities that move beyond the classroom and place the individual in direct contact with the world are extremely important in helping the student cultivate a sense of cosmopolitanism and urgency.

But this is not enough to accommodate the disparate dimensions of injustices that our examples above convey. The concept of the just transition in the JUST Framework [18] builds on *legal* geography. It aims to ensure the realisation of human rights and the protection of the environment in real life and in all stages of the energy life cycle. To this end, the concept advances different dimensions of justice [20,21,23,26,27,102,114,115,116] and these are explained in Table 1 below.

The language now is of justice, and this raises at least two lines of consideration when discussing education. First, injustices affect the realisation of the international human right to education, which is protected under article 26 of the Universal Declaration of Human Rights [117], article 13 of the International Covenant on Economic, Social and Cultural Rights (ICESCR) [118], and other international conventions [119–122]. For example, studies show that energy poverty affects educational opportunities for children and adults [42], and that access to electricity and clean cooking fuels may decrease school dropouts and improve school progression ([123], p. 14).

Second, education is a powerful instrument to tackle injustices, for instance, there is evidence that "education generates a negative impact on energy poverty" ([124], p. 1). Article 6 of the UNFCC [1] recognises the importance of education in the effort of the countries to tackle climate change. Further, the Sharm el-Sheikh Implementation Plan [2] affirms the importance of education to promote shifts in lifestyles. Several resolutions of the General Assembly of the United Nations affirm the importance of education for attaining SDGs, for example [125]. Similarly, UNESCO [126] calls for ESD to be fully integrated "into policies, learning environments, capacity-building of educators, the empowerment and mobilization of young people, and local level action", with the goal of building "a more just and sustainable world" (p. 14). To attain these objectives, a basic understanding of human rights and fundamental principles of environmental protection law is important to offer to the student the opportunity to critically think about the injustices that affect them (Table 2).

Indeed, the fundamentals of human rights law and environmental law need to be brought to the classroom – and, as we explain in Section 7, some case studies show that they have been brought, but not at the pace one should expect, and not within the context of the just transition. For instance, it is important for the student to understand that both the right to work and the right to health (ICESCR, Articles 6 and 12 [1]) *are human rights* conferred upon any individual living in any of the 171 countries who are parties to the ICESCR (to clarify: if a country is party to the ICESCR, it has an obligation to comply with the ICESCR).

Likewise, it is important to learn that indigenous peoples "have the right to decide their own priorities for the process of development as it affects their lives, beliefs, institutions and spiritual well-being and the lands they occupy or otherwise use" ([127], Article 7) and that

**Table 2**

The Five Dimensions of Justice for the JUST Framework. Based on [18].

| 1 | *Distributive justice* |
|---|---|
| | This means that not just the benefits but also the costs of the transition must be fairly distributed in society. Examples here abound, one of which is the case of some households and some regions disproportionately bearing the costs of a transition to renewables, as mentioned above. |
| 2 | *Procedural justice* |
| | It requires respect for procedures at all levels of governance, e.g. respect for environmental and human rights law. It is important to understand that certain procedures, for example the requirement of an EIA, are in place not to jeopardise economic growth but to protect the environment and human rights. |
| 3 | *Recognition justice* |
| | Requires the recognition of the other, for example indigenous and other vulnerable groups, on their own terms [102]. For instance, it is unacceptable that indigenous peoples bear the environmental and social costs of oil and gas activities that disproportionately benefit other parts of society. |
| 4 | *Restorative justice* |
| | This requires prevention of harm [21,23] and, if harm occurs, restoration of the environment and of the social fabric of trust [20]. Evidently, this involves formal judicial and quasi-judicial institutions and processes, but also other social non-formal institutions and processes. Restorative justice has a long pedigree, and it relies on the preparedness and willingness not of professionals but of the individuals involved with and affected by the injustice [115,116]. Dialogue based on love and hope [26,27] is crucial for enabling restoration of the social fabric. |
| 5 | *Cosmopolitan justice* |
| | This reminds us that we are all living in the same world and that we have a duty to each other not to pursue our interests by jeopardising the lives of others, in other parts of the world, who may be affected by our activities. For instance, it is unacceptable that mining in one locality affects the environment and people living in other localities, or that the batteries used in smartphones in one place are produced with child labour in another. |

indigenous people have the right to be consulted about energy projects in their lands. It is important for the student to understand that the 2015 Paris Agreement, which is another international treaty, calls for a "*just transition* of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities" ([128], Preamble). Moreover, the student needs to understand that all these conventions and treaties are international legal documents that create obligations on all countries who have ratified them, who must adapt their own laws to ensure that these rights and objectives are met. Once a country becomes a party to an international agreement, the country in question needs to comply with the treaty, and cannot, for instance, invoke its own laws to try to justify noncompliance with the treaty.

This is a powerful piece of knowledge, as it provides the student with a standpoint from which to critically assess the behaviour of governments, parliaments, authorities, and businesses. Students need to have the *opportunity* to understand the importance of compliance with these treaties – as well as with some of the procedures that they may directly or indirectly require (for instance the already-mentioned EIA). Compliance is not just mere bureaucracy that creates costs for businesses and slows down progress [102], but it is vitally important to ensure that nature and human beings are fully and justly protected. This type of knowledge needs to be brought to the classroom in an accessible language, with resort to activities that begin within but move beyond the classroom; some of these activities are described further in Section 7. CCR Education Framework brings this knowledge to the classroom, to promote a just transition to a low-carbon economy.

Critically, education can prepare the individual to be an agent in the transition to a low-carbon economy, to be a force of resistance against the oppression created by the fossil-fuel dominated neoliberal system

(Section 6). Education for just transition enables the individual to understand and act on the understanding of the space, time and justice aspects of a transition to a low-carbon economy.

## 5. From the JUST Framework to education as a practice of freedom

In the last section we introduced the concept of just transition within a legal geography framework. In this section we begin the translation of the concept into our view of education. We start by drawing attention to Article 13 of the ICESCR, in which the States Parties agree that:

…education shall be directed to the full development of the human personality and the sense of its dignity, and shall strengthen the respect for human rights and fundamental freedoms. They *(The State Parties)* further agree that education shall enable all persons to participate effectively in a free society, promote understanding, tolerance and friendship among all nations and all racial, ethnic or religious groups, and further the activities of the United Nations for the maintenance of peace [118].

What does the realisation of Article 13 entail in practice? Our argument is that it entails, at a fundamental level, the promotion of hope, solidarity, and critical thinking (Table 3).

bell hooks[3] [131] brings the concept of critical school to community

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[3] bell hooks is the pen name of Gloria Jean Watkins, who was an American academic, writer and activist. hooks, who decided not to capitalize her pen name to bring the attention to her work, was an important voice in black feminism [129,130].

**Table 3**
Key elements of education as a practice of freedom.

| | |
|---|---|
| Hope | Collective hope is a condition for the establishment of education communities that react to oppression |
| Solidarity | Solidarity in the fight against oppression as a condition for a new definition of what is means to be human |
| Critical | Critical education as rejection of the belief in a neutral education and of pedagogy of repression |

when she proposes a *pedagogy of hope*, contrasting two visions of the education and of the school. On the one hand, there is the perspective that situates the school as a microcosm of dominator culture: for instance, bell hooks [131] denounces racism and sexism in schools and colleges in blunt terms, which brings a darker dimension to aforementioned gender imbalance. But this is only one aspect of the oppression that the mainstream education can perpetuate – for Freire [25], the "oppressor consciousness tends to transform *everything* surrounding it into an object of its domination", and notably, "the *earth*, property, production, the creations of people, *people themselves*, time – everything is reduced to the status of objects at its disposal" (p. 58).

Diametrically opposed to this, there is education as a *practice of freedom* and the school as an environment of intense questioning, aimed at the rejection of subordination and humiliation in relationships based on the maintenance of power. This latter vision defines the school as a space of belonging, of mutual care and of appreciation of differences, and affirms education as a *space* that goes beyond formal education, with the conditions for fostering love and mutual respect, with humanitarianism as its guiding principle. *To hope*, for hooks [131] and Freire [24], is a condition for the establishment of educational communities willing to react to the violence of oppression in environments that are structurally hostile to the realisation of human rights – and, we now add, to the protection of nature. Even more, to hope is a necessary requirement for changing the world – as Darder explains in the introduction to *Pedagogy of Heart*:

> Through hope forged collectively, Freire contends, we discover the courage, strength, and emancipatory possibilities to challenge social injustices taken for granted in the past. In this way, hope also inspires our collective vision and participation in changing the direction of our future, by opening us to new definition of what it means to be human ([27], Introduction).

Accordingly, educational communities can foster the sense of urgency mentioned above, without falling hostage to anxiety and immobility. Further, the realisation of full humanity, for Freire [25], cannot be attained through individualism and alienation, but through "fellowship and solidarity" (p. 85), so the rights of one individual are not secured to the prejudice of the rights of others. Teachers and students work together towards freedom from oppression.

Evidently, this challenges the traditional affirmation that education should be taught without bias. By now, it should clear that science and education are not neutral [132–134]. In the face of mounting inequality, erosion of democracy and climate change, education should have a bias, i.e., it should be fully committed to enabling individual and society to deliver a just transition to a low-carbon economy. Furthermore, as Giroux explains [135,136], no education can be considered ideologically neutral. Neutrality hides what education involves as producing forms of knowledge, power, social values, agency, and narratives about the world. Therefore, the rejection of the belief in a neutral education – and the defence of a critical education and of the school as an opinion-forming space – unites all the cited authors and their work. In contrast, education can become hostage of ideology, with curricula that are narrowly designed towards certain objectives, which jeopardises critical reflection [137]. In this sense, critical pedagogy emerges as a challenge to face what Giroux [136] calls the *pedagogy of repression*, i.e. a pedagogy that aims to diminish the possibility of students to be critical thinkers. In

other words, a critical pedagogy prevents education from being an instrument of silencing, instead enabling the individual to socially engage with the tackling of climate change.

This critique is relevant because one could eventually assume that pedagogical approaches to educate for a just transition can be another knowledge set to enable students to operate in the market. However, this assumption transforms learning into a mechanical process rather than something that can help students acquire a transformative agency in the world. Our understanding is that schools and informal educational settings can play a key role in promoting a just transition, but only if they adopt approaches that are committed to enabling a transformative (individual and collective) agency, as the ESD literature proposes [28], with full awareness of past energy injustices and the risk that the transition may aggravate these injustices.

This involves changes in curricula but also in the role of the school. As Freire [25] explains, curricula are never unbiased or simple prescriptions: they are epistemological, political, social, economic, ethical, and aesthetically conditioned. Reflecting the power relations, curricula are not static or immune to debates and conflicts around societal and science-related issues. Both the curriculum and the school are the setting for disputes and negotiations over the selection of curriculum contents and teaching methods, and they are therefore influenced by the interests of social groups and institutions.

We argue that knowledge of the aspects of legal geography described above is an important step in helping the individual develop critical thinking about the transition to a low-carbon economy, to react to violence and reaffirm their position towards society and environment. As hope is a condition for reacting against violence, understanding the power of human rights and environmental law principles can be seen as an enabler of both hope and the realisation of hope in practice. To summarise the above, we call for a rejection of education that reduces nature and the other to objects of domination, and for education as a practice of freedom.

## 6. Neoliberal science education is not fit for a just transition

How far are we from this? Let us reflect on it in relation to STEM education. More than twenty years ago, Millar and Osborne [138] published what became a very influential report proposing new aims for science education for the new millennium. They were concerned with meaningfulness in science learning to the lives of all youngsters and were advocating a humanistic curriculum that would not just serve future scientists. In the first paragraph of the report, they argue:

> Education, at the end of the 20th century, no longer prepares individuals for secure, lifelong employment in local industry or services. Rather, the rapid pace of technological change and the *globalisation of the marketplace* have resulted in a need for individuals who have a broad general education, good communication skills, adaptability and a commitment to lifelong learning ([138], p. 2001).

The very important argument for a humanistic and effective science education that caters for the needs of all students is not new, and has gained several slogans over the last century, such as 'general science', 'science for all', 'science, technology and society', 'science literacy' and others [139–141]. However, the quotation above is significant because of its concern with the "globalisation of the marketplace" ([138], p. 2001), which led to several educational needs.

In line with this, in the last decade a significant body of research on the teaching and learning of twenty-first century skills has emerged, highlighting that there is a relevant aspect of schooling in which pupils develop underlying skills such as critical thinking, creativity, communication and collaboration (the 4Cs) [142,143]. Similar to Millar and Osborne's [138] vision, Mansfield and Reiss [144] have argued that there has been a shift in the aims of science education with it moving *away* from educating students to become scientists, to a focus on educating for the jobs of tomorrow. They have shown how the rhetoric

of stakeholders in the United Kingdom and in other Western countries has emphasised the importance of STEM education to compete internationally and to prosper economically. Of course, innovation and its contribution to economic growth must be factored in too. Mansfield and Reiss [144] claim that globalisation has escalated competition at a national and global level, which increased pressure on the educational sector, in STEM education, to respond to employability, business growth, creation of high-wage jobs, and economic prosperity demands. In summary, the latter authors explain that "education and innovation are seen as a means of economic survival and transferability" and that "political agendas speak of education as a way of preparing students as 'marketable commodities', able to enhance national economic and innovative competitiveness in a global climate" (p. 194).

The issue is not with entrepreneurship per se which, in the scientific milieu, interplays with creative technological innovation. Depending on the social-economic context and on the manner that this interplay materialises, entrepreneurship and innovation may drive social transformation and promote better living conditions to the population [145,146]. Examples abound, but for the present purposes, we highlight that community renewable energy projects may help countering energy poverty and theft [147,148]. Therefore, issues of global competition, employability, security, prosperity impact STEM curricula. But we cannot ignore the fact that entrepreneurship and innovation have been used by globalisation and neoliberal agendas to create a curriculum *disconnected* from building a sustainable future for the common good. An example of this disconnection is the often-made mistake of confounding economic growth with sustainable development, whereby it is assumed that an increase in Gross Domestic Product trickles down as development for all [110], that entrepreneurship and innovation *always* lead to sustainable development, notably for the peripheries. Violations of human rights of indigenous peoples and those living in peripheries, and pollution of the environment are often justified by political and economic leaderships as necessary for the development of the nation [57,102].

When education incorporates this disconnection, a curriculum is created that is unable to respond to the urgent need of a just transition to a green economy. The shift in the aims of science education that Mansfield and Reiss [144] refer to is the tip of the iceberg of a much bigger problem, namely, the *commercialisation* of the academia. This problem affects the relationship between the university and the academic [149], but also their relationship with the fossil fuel industry [93–95]. This commercialisation should also be understood in terms of the coloniality, as discussed above. As Lave et al. [150] show in detail, since private corporations have overtaken state-subsidised funding to become the main funders of techno-scientific production, universities are becoming corporations – providers of human capital – instead of educating professionals with high levels of citizenry. The neoliberal view has permeated mainstream education. Consequently, new scientific discoveries, technological innovations and scientific skills have become assets and commodities of private industry that are commercialised. Profiteering is the main objective of corporations and with scientific knowledge being the means. Intellectual property has become a new asset class driven by profiteering rather than to contribute to solving societal problems. Carter has written extensively [151–154] about how neoliberal politics has instilled into the minds of people an ideology that values competition, individualism, entrepreneurial behaviours and about the impact of all this in science education. Neoliberalism takes STEM professionals as the assets, the human capital of the industry and governments to compete nationally and internationally [153]. Like Mansfield and Reiss [144], Carter's analysis of the rhetoric of several stakeholders reveals their concern to see students in the STEM pipeline respond to the growing consumption demand.

Neoliberalism has become "common sense" in the way many people interpret the world and live their lives [154]. Common sense became something to do with individualism and shallowness in the neoliberal market. Krishna [155] has explained how globalisation has changed the

social contract between science and society, transforming 'academic' science – as a social institution that operated under the ethos of public good of knowledge – into 'post-academic' science – one that, instead of serving the public good, serves the market good.

Ironically, the perspective of the neoliberal engine places freedom of choice for the individual as the top priority for a fulfilling life at the expense of removing social safety nets [156]. But without safety nets, individual freedom is reduced. The neoliberal narrative makes people *believe* that the pursuit of one's own selfish interests, at the expense of nature and of the other, will eventually benefit society and resolve all social problems [156]. This individualistic, capitalist narrative is unsustainable because it teaches the individual to see the other and nature as instruments for the individual to pursue to realise his or her own interests – it teaches the individual to become an oppressor. Now, violations of human rights, notably when affecting minorities in the peripheries, and damage to the environment are justified as necessary for ensuring individual success and collective economic growth – which is necessary to ensure freedom of choice.

The way freedom of choice is realised in the market is disturbing: the individual learns that the freedom to choose, and the ability to access, different, *cheap* products and services is desirable – while ignoring the hidden social, environmental and energy costs associated with the huge range of cheap products and services. Freedom of choice coupled with ignorance of hidden costs may lead to injustices. For example, Senator Durbin alerted all to a situation in the US when justifying a bill to require certification of minerals from Congo, "tens of millions of people in the United States may be putting money in the pockets of some of the worst human rights violators in the world, simply by using a cell phone or laptop computer" [157]. For school students, learning science in general has little altruistic or disinterested aims, but instead is part of the competition game required to access the cultural capital for maintaining or moving up in the social class ladder [158]. This stratifies society into a small number of knowledge builders and a great number of uncritical consumers [158].

We should now reflect about what traditional mainstream STEM education has been doing to educate youngsters to become critical thinkers about science, technology, and the deregulated exploitation of nature and the other that are favored by neoliberal agendas. Extreme conservative teaching is detrimental to critical thinking skills and has even been associated with unintentional indoctrination [159]. If teaching is limited to concepts and models being introduced as 'facts' by the teacher, for example "the Earth rotates around its axis", "all matter is made up of molecules", without proper explanation about the reasons behind it, the students create the habit to accept the teacher's authority as a source of knowledge ([159], p. 287). If the physics teachers explain to students how new electric cars work without discussing the social and environmental impact of metal extraction in the poorest parts of the globe, they will be missing opportunities to educate for a better world for everyone. Regarding this conservative form of education, Bazzul and Tolbert [160] have insightfully commented, "Science education, in its conservative formulations, may simply be a distraction from much more important concerns" (p. 2). Priorities should include tackling climate change, inequalities, poverty, and building an ethical and sustainable way of living that brings about water, energy and food security – i.e. priorities in moving towards a just and low-carbon world.

As Bazzul and Tolbert [160] add, science educators seem to have great fidelity to their 'field', while seeming reluctant to come to terms with scientists' work towards social transformation. This is not too surprising. As Bencze and Alsop [158] explain, scientific activity is normally mistakenly seen as unproblematic and separated from politics and power struggles, and as something which inevitably leads to truth, progress and well-being. Seen as such, they add, school programmes which do not critically address the social impact of scientific activity will function as incubators of neoliberal agents, making neoliberalism and the systems that it sustains, such as energy systems, part of their sub-consciousness [158]. In addition, these programmes do little to tackle

inequalities.

In these traditional programmes (which emphasise the learning of abstract concepts and models and the methods of science, with little application in the everyday world), the teaching of science has been used as a 'selection camp' favouring those who carry the sort of cultural capital more likely to be present in wealthier families [161]. While knowledge of legal geography provides important grounds for the introduction of critical thinking into education, including STEM education, we can now say that it is knowledge of history, and of the history of the social and environmental impacts of science and technology, that completes our framework. As Freire [27] explains, "critical conscientization in history" (p. 75) – the understanding that history is not dead, that it is always in the process of being made, and that the individual must participate in its making – is of paramount importance. But the individual must be able to see what the individual and the society

can *become* [25]. For Tribe [137], *becoming* "carries with it visions of the future and considerations of utopia" (p. 6).

In this scenario, educators have been seeking to come up with alternative pedagogies that overcome the gap between science and social justice. For example, Bazzul et al. [162] have called for a reimagination of science education. They are concerned with the orthodox thinking in science education and urge the community to think differently, politically and philosophically [162]. Bazzul and Tolbert [160] call for the community of science educators to reflect about love beyond "love of self/extensions of self (e.g., our own genetic families) toward a love of/for/with the multitude" (p. 5), to think about science in the name of justice and to promote collective freedom. The call is for educators to fight the politics of domination [163], which is in the centre of neoliberalism. The CCR Education Framework, which we introduce in this paper, resonates with these proposals.

**Table 4**
The CCR Education Framework.

| C | *Critical thinking* |
|---|---|
| | This has a background of geography of the just transition, the history of science and technology, and the affirmation of human rights and environmental protection. In practice, this translates into the adoption of interdisciplinary curricula. Some of the cognitive learning goals: <br> • To understand the negative impacts of economic activities linked with the energy sector on human and socio-economic rights and the environment, within one's own country and abroad (cosmopolitan justice). <br> • To understand the disproportionate impact on those who are already marginalised, e.g. women, children, minorities, indigenous peoples (recognition, distributive justice). <br> • To understand that should such negative impacts occur then they should be addressed, with restoration of the environment and the social fabric (restorative justice). <br> • To understand that international law creates rights for individuals and obligations on governments, and that procedures are in place to ensure respect for human rights and the environment (procedural justice). <br> • To understand that a proper account is given to the world views of the periphery (recognition, cosmopolitanism), notably when these world views are crucial in protecting the environment (restorative justice). |
| C | *Coexistence with the other and nature* |
| | We need to instil awareness in the individual about the importance of solidarity and help the individual to develop the skills to build solidarity. In these terms, coexistence becomes an action based on all the dimensions of justice explained above. Education must promote a dialogue of love, which replaces the dialogue of oppression [25]. The main socio-emotional learning objectives associated with the transition are: <br> • To develop skills that enable the individual to live with the other. <br> • To develop skills that enable the individual to live with other communities, notable in the peripheries. <br> • To develop skills that enable the individual and the community to live with nature. |
| R | *Resistance against the dynamics of the status quo* |
| | Resistance clarifies that education is not unbiased and that today a transformation is needed that must promote, rather than jeopardise, the just transition to a low-carbon economy. Pedagogies must promote freedom and hope [26,27]. Behavioural learning objectives include: <br> • Ability to reject the *status quo* insofar as that *status quo* exploits, oppresses nature and human beings and distributes the benefits and costs of economic activities unevenly across society. <br> • Ability to refuse to participate in the vicious cycle of oppression, at the same time engaging with the promotion of new, healthy cycles with due respect for nature and human rights. <br> • Ability to engage in economic activities that are properly designed and implemented, having in mind respect to the other and to nature. <br> • Ability to demand that governments and businesses design and implement their activities accordingly. <br> • Ability to both imagine an alternative, greener future, an alternative history-in-making, and work towards this future. |

## 7. CCR Education Framework

Our critique of mainstream education emphasises its capture by neoliberalism, which jeopardises the ability of the individual to imagine and work towards a different future. Acknowledging this reality allows us to close the theoretical framework and advance more precise learning objectives for implementing a just transition. In contrast with the neoliberal education model, we propose another philosophy that is built on three pillars and is described below in Table 4. This connects critical education with the UNESCO learning goals, ICESCR and other relevant treaties, as described earlier, but also engages with the different forms and principles of justice [13] including intergenerational.

### 7.1. CCR Education Framework and teacher training and education

Before anything else, the CCR Education Framework requires that all types of teachers develop a more interdisciplinary, and less formalistic approach, to their disciplines, and a clear understanding of teaching and schooling as *enablers* of social participation and promoters of understanding and tolerance, in the true sense of article 13 of the ICESCR [118]. In other words, as Brown [164] explains, we need to move away from the classical understanding of knowledge as "a kind of substance" (p. 18) that is passed through from teacher to student, and towards the understanding of the social context in which knowledge is situated, placing emphasis on the "learning activities and human interactions" (p. 18) that embed knowledge of a topic.

Teacher training and education must adapt to the new challenges posed by climate change and the transition, to enable teachers to bring these elements to their teaching, irrespective of the subject. This is no small feat, but it is clearly feasible – there is a growing literature (and again it is not our objective to exhaust it) on the use of different approaches, with the discussion of interesting case-studies, to promote sustainability and human rights [165,166] and implement interdisciplinarity [167]. More of these studies, clearly addressing the context of the transition, are necessary. Further, this requires proper teacher training and education [168–170]. We need more research that investigates pedagogical strategies to bring human rights to the classroom, from elementary education [171,172] to more advanced education, including STEM higher education [173], and on how to prepare teachers for realising these strategies – all in the context of the transition. Further and corresponding with the components of justice is the need for the consideration of ethics [174].

Hence, teacher training institutions should adapt their curricula to address climate change and energy transition from a critical perspective, reflecting on local, regional, national and global challenges and injustices. Ultimately, as Freire [175] believed, teachers ought to be very familiar with the links between theory and practice, and what they say and what they do. In Freire's [176] words, "… in the process of the ongoing education of teachers, the essential moment is that of critical reflection on one's practice. Thinking critically about practice, of today or yesterday, makes possible the improvement of tomorrow's practice" (p. 44). Trainee teachers at all levels should therefore be encouraged to reflect critically about their practice and cast a critical eye about educational aims, curricula methods and content. Further, they should teach critically about energy resources, innovations and environmental impact provoked by human activity, particularly on the most vulnerable.

### 7.2. CCR education framework and pedagogical approaches

As a starting point, we have opened the discussion around pedagogical approaches that could be potentially employed within the CCR Education Framework in alignment to their respective energy justice pillars.

### 7.2.1. C – Critical thinking

An example of an approach that has the potential to advance this pillar is community and territory integrated education, as applied by educators in Brazil, in which children from vulnerable or minority groups can participate in projects aiming at the protection or restoration of the environment and, in the process, revindicate their individual and collective identity [177]. Likewise, Kato [178] advances the decolonisation of knowledge by articulating a polysemic understanding of the environment and bringing the world views of indigenous and traditional communities, with emphasis on the concept of Pacha Mama, to inform education. Kato [178] advances proposals ranging from the training of educators, including through international cooperation, to popular education.

Although these studies lack linkages between the objectives pursued by the projects and interventions and the learning goals of the CCR Education Framework, these linkages can be made. From the viewpoint of the CCR Education Framework, case studies such as those reported by Bizerra [177] and the proposals put forward by Kato [178] can promote *C – Critical thinking* through as stated below:

- recognition justice (affirmation or reaffirmation of students' identities);
- restorative justice (understanding of the need to avoid harm and, if it emerges, to restore the environment and the social fabric);
- cosmopolitanism (especially Kato's proposals in bringing about concern with traditional communities elsewhere); and
- distributive justice (as students recover the environment in which they live, correcting the fact that development policies are unfairly distributed, with the students' communities paying the price in terms of environmental pollution).

Small pedagogical interventions for example in respect to recycling can foster critical environmental awareness, and these can be easily incorporated into education as part of a new way to relate to waste, the environment and energy. Such an example is tangible and easily achievable. It can generate a sense of agency and increase levels of environmental awareness by questioning the reasons why some industries still use non-recyclable materials; why we consume certain products in such amounts, and why some parts of society bear most of the costs, including environmental costs, of this consumption. The UNESCO proposal on ESD clearly addresses this point (see Table 1). But this process of fomenting critical environmental awareness can become gradually distant from everyday life, with increasing loss of the sense of climate urgency, and changes may no longer be achievable within everyday practices (such as recycling). This is a crucial area in which educational processes for a just transition need to operate: it is necessary to continuously close the recurring gap to what is apparently intangible or distant from everyday life and recover the sense of urgency.

Mindfulness pedagogy is another important approach in that it helps the student question the unsustainability of the *status quo* without falling into climate anxiety [179], which has become a problem [180–182]. Philosophic practitioner education [137] although lacking the crucial focus on justice, brings an important contribution in terms of promoting critical reflection.

However, a *normative* perspective should also be introduced under pillar *C – Critical thinking*, to help students understand what has been done, the damage this caused and the damage that students can address with their interventions. This is in contrast to what has and should have been done – having in mind the human rights of students and all individuals in the society, the obligations of governments and the responsibilities of businesses towards humans and nature. In this manner, procedural justice (that is, compliance with human and socio-economic rights and environmental *law*) gains materiality in providing the grounds for a normative thinking that feeds into critical thinking.

### 7.2.2. C – Coexistence

A central concern under this pillar is the impact that decisions and behaviours in central countries can have on vulnerable communities in the peripheral countries. This can be illustrated with the Solarize campaign case or the conflict minerals case described above. Another concern is the impact of decisions and behaviours on the environment. Different pedagogical approaches such as those described by Kato [178] and Kalsoom and Hasan [183] can also help students develop skills to live with the other and with nature.

Under this pillar, pedagogies are necessary which promote cosmopolitan justice and address an important and complex challenge that just transition faces, i.e., that the transition should be global. As Gadotti [97] proposes, education needs to introduce the individual into a community that is both local and global. It can be difficult to account for the role of localised agency for more structural and global issues. For example, a study conducted by Wilbanks and Kates [184] on GHG emissions showed that individuals have great difficulty linking their individual activities and decisions to changes at the global scale. It can be even more challenging for young children, due to limited space-time experiences and reduced ability to articulate different geographic scales and sociocultural layers. In addition, it can be challenging to make practical links between localised actions in one place and their impact on localised issues somewhere else.

In our view, one way to make centre and peripheries more relatable is by "zooming in" to enable both sides to see each other from a closer perspective, which may help to address the issues of moral judgement on individual decision-making. This can be advanced with the creation of a space where horizontal lines of *conversation* [185] overcome symbolic barriers and prejudice and enable mutual understanding. The learning process needs to be embedded in horizontal lines of conversation in which the other, who is typically the *object* of learning (the distant community), becomes a *subject* of learning. It can be, for example, a visit to a local community, or even a mini project facilitated by the Internet, putting together the two sides (students and the "object of study") as active subjects of learning.

### 7.2.3. C – Resistance

Finally, the type of actions outlined above may also fall within the *R – Resistance* pillar because pupils acquire important skills for participating through real action *outside* of the classroom. But there are different pedagogies that may advance this pillar more directly, for instance the pipeline pedagogy which has a clear concern with justice for indigenous people (in the energy sector) and with empowering individuals to act [186], and educational leadership strategies informed by the Freirean thought [187].

Acquiring critical consciousness about the environment and human rights is crucial, not only to understand the implications of environmental issues for society but also to adopt a mindset for change. But it is the bringing of this knowledge to action that helps in the development of the skills necessary for a constructive rejection of the *status quo*. As the examples show, the learning process incorporates critical pedagogy but also what Freire [25] defines as "critical consciousness" (p. 73). Students are recognised not merely as recipients of knowledge, what Freire [25] calls "banking education" (p. 6), but as *active* learners, *capable* participants who are able to critically engage with the subject learned, understand the power relations that affect the teaching and learning of the subject, and make use of critical conscious knowledge to transform the world.

## 8. Conclusion

We began our journey by drawing attention to the importance of the energy sector to our lives. GHG emissions have resulted from it and caused major climate, environmental and social costs. A transition to a low-carbon economy is urgent and must occur globally and be 'just'. To address the different dimensions of injustices we adopted the JUST

Framework which draws on legal geography to emphasise the space and time of climate change, and five dimensions of justice: recognition, cosmopolitan, distributive, procedural and restorative. We explained that the way to bring this framework to education is for education to incorporate the fundamentals of geography and history, human rights and environmental law. But this would not be enough for education to promote the just transition. To address this, we drew on the Freirean critical education school to reject oppression, which reduces humans and nature to mere objects of domination. Instead, we called for a dialogue based on hope, which should be forged collectively to build education communities that react to oppression; on solidarity, to overcome oppression and as a condition of a new meaning of humanity; and on critical thinking, with the rejection of the belief of a neutral education and of pedagogies that cement oppression.

We then discussed how mainstream education is distant from our call, as it has fallen victim to the neoliberal engine that severely compromises the ability of the individual for critical citizen engagement to build a green economy. To tackle this, we proposed the CCR Education Framework: *C – Critical thinking*: education must promote critical thinking grounded on legal geography and history; *C – Coexistence*: education must help the individual to develop the skills necessary to coexist with nature and the other; and *R – Resistance*: education must also help the individual to develop the skills necessary to reject certain forces of the *status quo* and to imagine an alternative future and work towards it.

We discussed examples of pedagogical approaches and teacher training and education. Notably, we showed that the CCR Education Framework can be a strategy for tackling one of the most complex challenges that we face when promoting a just transition, which is the extreme lack of urgency that individuals in general demonstrate towards climate change, ignoring the climate emergency, as declared by the UN Secretary-General [188]. Climate change is a long-term event where the effects are not immediately perceptible to all. Future generations – beginning with the children of today – will suffer its effects. Building solidarity with future generations is crucial. In enabling children to be agents of cultural change and mindset shift, education can succeed where democratic processes today fail. Children can become champions in terms of a new form of coexistence, by helping to forge new social norms, for example by sharing what they learn with their families (and communities), as well as by practising change in everyday life and as they grow up [189].

We emphasised the central place of teachers, teacher education and educational institutions in the implementation of the CCR Education Framework. The CCR Education Framework demands engaged educators to challenge existing structures of power that sustain models of education and pedagogical approaches centred on "banking education" (which students are recognised merely as recipients of knowledge). Instead, education must enable educational practices that incorporate values of social justice, human rights, protection of nature, socioeconomic well-being, and harmony. Teachers should learn and espouse values of hope and solidarity and teach the skills to live sustainably with others and with nature, and to advocate social harmony in our societies against all forms of oppression. Innovations (for example, solar panels) need to benefit all and be more accessible to peripheral countries and communities. Likewise, this perspective for education on clean energy innovations need to be central to future research.

We note that the CCR Education Framework succeeds where neoliberal education fails. It acknowledges and gives visibility to the struggles of peripheral groups, who tend to be on the margins of major economic and political decision-making. By doing this, the CCR Education Framework creates a new common sense based on critical thinking, coexistence and resistance, in which the consequences of individual and societal decisions are more accountable and relatable to peripheral groups. The CCR Education Framework can be a model applied across countries. Future studies can explore its impact and also a more in-depth analysis of the transformative change needed in STEM

and energy (all disciplines) education; and we note that the aforementioned articles from Nature allude to this [16,17]. Finally, it needs to be recognised that change in education must happen and must happen fast, as we notice the change in the international debate from climate *emergency* [188] to climate *survival*, as the "window of opportunity to secure a liveable and sustainable future for all" closes rapidly ([190], p. 25.). Society needs to stop imbibing from the educational system status quo and transform it for the just transition with urgency.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

No data was used for the research described in the article.

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