How not to climate communicate: understanding directionally motivated reasoning and its impact on climate change education

Mary Gagen summarises why, and how, learners' beliefs and life experiences shape how they interpret climate information and why we need to consider this when sharing factual knowledge in the hope of inspiring climate action

Views on climate change have become a shorthand indicator of what kind of person you are and, even from a young age, children and young people understand the importance of feeling a sense of belonging to their social group. The tendency we all have to interpret information in line with protecting our individual belief systems is known as *politically, or directionally, motivated reasoning* (DMR) (Kahan *et al.*, 2012; Kahan, 2012, 2017). It has been demonstrated to strongly influence how adults process factual climate information and is suggested to do so in children too. In its essence, DMR theorises that individuals reject new facts if they contradict their standing beliefs. It is based on neuroscientific, psychological and political science research and has been well tested and found to be particularly strong in the case of contentious topics such as climate change. DMR is the strongest modulator of how well, or poorly, factual climate change information lands with an individual, but most of us delivering climate change education have never heard of it. At a time of dire need, in terms of global climate action, and a pressing need to place children and young people at the heart of our drive for a stable climate future, how do we as educators navigate through the complicated social science of communication when sharing climate knowledge in our classrooms and lecture theatres? In terms of the scope of this article, I believe the considerations around how we climate communicate are relevant to all those attempting to share climate information in an educational setting. However, the concepts discussed may be most relevant to key stages 3 and above in a school setting (ages 11+), and in further and higher education settings.

Background

There is scientific consensus on the human cause of current climate change, and on the catastrophic impacts if we fail to reduce greenhouse gas emissions and stabilise our climate (IPCC, 2021). However, despite this scientific alignment, societal acceptance of the evidence for climate change has not dramatically increased over time (Petersen, Stuart and

Gunderson, 2019), nor has it scaled into widespread, global climate action. Children and young people struggle to understand the '*climate fact – climate inaction*' paradox and are also the demographic who will have to deal with the consequences of climate change, as we move to, through, and past 1.5 °C to 2.0 °C of warming. As such, it is my view that helping learners, and ourselves, to understand what leads to climate inaction can help us to navigate the choppy waters of teaching 21st century environmental grand challenges.

Children and young people are both emotionally engaged with climate issues, and keen to understand them, so it is vital that we get climate communication in education right. Unfortunately, the field of climate communication has not always done a great job of giving educators straightforward, and successful, tools to support climate change education (CCE). The aim of this article is to explain why teaching people of any age climate facts alone, to fill a perceived gap in knowledge, is not the best climate-communication strategy for achieving action, and what other methods we can use to underpin our CCE.

Throughout this article there are a few guides I return to for those seeking further knowledge. The first is the body of work from Dan Kahan (Kahan *et al*., 2012; Kahan, 2012, 2017). The second is the work of Louise Archer and colleagues on 'science capital' (Godec, King and Archer, 2017). Their Science Capital Teaching Approach offers a useful methodological lens through which to consider the scientific position of the learners who are at the centre of our CCE, and to acknowledge their lived experience of science. For those who wish to go further, the 'school strikes' edition of Bronwyn Hayward's book, *Children, Citizenship and Environment* (Hayward, 2020), gives a more comprehensive introduction to the topic and useful insights into the environmental citizenship-focused SEEDS methodology (Social agency, Environmental education, Embedded justice, Decentred deliberation and Self-transcendence). Literature around deliberative engagement, or deliberative democracy (Willis, Curato and Smith, 2022), which includes methodologies such as deliberative mini-publics and citizen assemblies, can also be useful in the climate classroom. All of this, of course, provides useful context alongside the wealth of CCE literature itself, usefully reviewed elsewhere (Leite, 2024).

Introducing the knowledge-deficit assumption of climate communication, and the DMR response

The University College London *Handbook for Communicating Climate Change* defines climate communication as '*any formal interaction about an aspect of the global climate change challenge, often in the form of imparting knowledge*'. This common framing, favoured widely in climate-communication spheres and by the United Nations (UN), places the climate-inaction problem under an umbrella of being caused by a societal '*knowledge deficit*' around climate change. In this assumption a simple one-way transfer of climate facts and expertise, aimed at changing hearts and minds, is all that is needed to provoke widespread climate action. When it comes to applying the knowledge-deficit assumption to communicating climate change, a central view is that '*we can change people's behaviour if we teach them things*' (phrased from Hay Festival, 2024). However, we know that has simply not worked (Peterson *et al*., 2019).

Evidence from communication, neuroscientific, psychological and social science fields (Kahan *et al*., 2012; Kahan, 2012, 2017) makes it clear that the knowledge-deficit approach is not a useful one with regards to CCE for action. It seems that, in the main, contentious topics are not processed by the human mind based on scientific fact alone. They are processed through a lens of our personal politics and socio-cultural positions and our strong sense of needing to belong. We are social primates, and adopting a view that goes against that held by those we are closest to feels risky to us. We rather process facts in a directionally motivated way, rejecting those that contradict our standing beliefs (Druckman and McGrath, 2019). When we

are faced with climate facts, humans of any age process that information, not on the basis of logic, evidence and a motivation to seek accuracy, but via our beliefs, feelings and personal, social, cultural and political histories. The result of those feelings causes us to push back strongly against accepting evidence that would go against what '*people like me*' think. That process strongly contests the assumption that we can influence people about climate change simply by teaching them the facts.

As Dan Kahan illustrates (Kahan *et al*., 2012; Kahan, 2012, 2017), and as mentioned above, humans filter out information that would drive a wedge between themselves and their peers, meaning those with different values draw different information from the same evidence – an effect known as '*politically, or directionally, motivated reasoning*' (DMR). In brief, as individuals we reject new information that contradicts our standing beliefs.

So why is there a link between DMR and climate action? This is because accepting factual climate change evidence requires, at its core, accepting that human activity has caused dangerous climate change. If we cannot accept that human activity has caused climate change – on a personal level because of our personal politics, values and beliefs, or in the case of young people those we have been taught – we are also likely to reject the need to change our own activities. Accepting that humans have caused climate change is a precursor need to taking climate action.

While research into political psychology generally ignores children, unfortunately for those of us trying to provide CCE, what research has been done suggests children may also exhibit DMR (Archer *et al*., 2015; Godec *et al*., 2017; Reifen-Tagar and Cimpian, 2022). However, the majority of climate communication and CCE advice is still based on the assumption that climate inaction is the result of a gap in knowledge, and teaching children and young people climate science facts will lead them to take climate action.

I have practised as a climate scientist and educator for two decades, and the continued use of knowledge-deficit climate communication, ignoring an understanding of DMR, has become a concern to me. This article is my attempt to share the experience I have gained as I have moved my climate communication away from the fallacy of assuming that filling a gap in knowledge is all that is needed to inspire the climate action we need to combat dangerous climate change, to understanding the need for learner-centred, socio-politically aware climate-communication methods (see Box 2 for examples).

It is not surprising that the knowledge-deficit approach is so pervasive; in fact, learners themselves often relate strongly to a climate-activist argument based on the same assumption: that if people were simply to understand climate science, they would take action. Speaking at the US Congress in 2019, Greta Thunberg summed up that position with her demand, '*You must unite behind the science. You must take action.*' The argument of the climate activist can seem, sometimes, to ask us simply to understand the science and be guided into action by it alone. That view is reinforced by governments and businesses, with the notion that individual behaviour, not governance and responsible business practice, can save our climate. Bronwyn Hayward argues that this is akin to the view that people can be taught responsible and sustainable consumption, '*just like they can be taught not to litter*'. The analogy of litter picking is an excellent one in this context, the 'Keep America Beautiful' litter campaign having been started by canning and bottling companies in the USA who were concerned at the rise of 'bottle taxes' aimed at putting the cost of litter clean-ups on companies. The success of their campaigning, which marketed the idea that materials pollution was an individual, consumer problem, not a business problem, was so successful that it is still of influence now, as we mobilise beach cleans and litter picks to combat plastic pollution, with far greater success than we bring in plastic taxation or a global plastic treaty. If only this position was 'the answer' and capable of delivering global climate action at pace, we would have met global climate targets long ago. The problem, of course, is that disposing of our litter responsibly, or participating in a litter pick, makes us feel good and has few negative

impacts on our lives. Living a lower-consumption, low-carbon lifestyle, however, comes with perceptions of depriving ourselves of things we like, and, at the moment, it also comes with huge expense – part of the inequality of the cost of climate solutions (e.g. Henderson, 2020).

There is another problem with assuming that climate facts will inspire climate action. When we present, sometimes unintentionally, climate knowledge as something held by a few, to be revered and accepted without question, we arouse suspicion in those who do not feel science is 'for them' because access to science is so profoundly unequal (Dawson *et al*., 2020; ASPIRES Research). Suspicion blossoms when there is a significant perceived cost to accepting the climate science one has been presented with. Accepting climate change might be perceived as meaning giving up flying, the family car, eating meat, and so on. These perceived costs can, in the short term, appear severe to the individual and also appear to ask them to lose identities that are strongly held.

The opposite is also seen to be true in the limited literature that exists around what motivates young people who do participate in climate action. Once again, we see the impact of the natural tendency humans have to want to do things that give them a sense of belonging. For example, a group of researchers (Wallis and Loy, 2021) investigated whether a perception that parents, families and friends were in favour of environmental activism positively correlated with young climate activists' participation in Greta Thunberg's 'Fridays for Future' (the school strikes for climate). Interestingly, it was found that although parents' level of climate and environmental engagement correlated with how often the young people attended a climate strike, it was their friends, rather than their parents, who were the decision role models for their climate-action behaviours.

In Box 1, I summarise some of the research discussed above. This research can be thought of under six broad headings that help us understand why delivering 'deficit approach' factual climate knowledge may not always be the best way to inspire climate action in our learners.

Best practice: when we seek to deliver climate education it is important not to assume delivering climate facts inspires climate action in all

The literature base for understanding why the knowledge-deficit approach fails to support climate change communication is widespread. It comes from a diverse set of fields: communication theory, social science, neuroscience, psychology and public policy. However, belief- and view-based climate change rejection responses broadly fall into two groups:

- Our socio-politically motivated responses, which are often around perceptions on the economics of natural resource use.
- Our psychological responses, which are often about how the human brain processes information, defends our sense of community, and minimises feelings of risk.

So where does an understanding of effects such as DMR leave our climate change education? Dan Kahan's continuing research revealed something interesting when considering how different groups of individuals express DMR. Having demonstrated how personal beliefs and leanings are a strong predictor of views on climate change, Kahan's team then investigated whether any particular types of people expressed stronger, or weaker, DMR. It turns out, in adults, those who express a particular curiosity for science, people who like to read about science and watch scientific shows, for example, demonstrate lower motivated reasoning around climate change than those with no particular curiosity for science (Kahan, 2017). We might reasonably wonder if this response might be the same in children and young people.

Box 1 Why does understanding climate facts not necessarily lead to climate action?

There is a wealth of useful literature to help us understand how those who deny climate change set up arguments to counter climate-science facts; a good starting place is Mark Maslin's accessible article 'The five corrupt pillars of climate change denial' (Maslin, 2019). However, it is different literature that we must access to understand why there is a mismatch between climate knowledge and climate action, if we are to help learners to understand this paradox too. Most of us would probably assume that an audience given access to more climate knowledge would be likely to get on board with the need for climate action. The fact that this does not occur seems paradoxical. The literature that helps us understand this comes from social, political and neuro science and it tells us that there are socio-political and psychological reasons for climate inaction in the face of facts. Below is a very brief introduction to these paradoxical positions, which are essentially emotion-driven responses to information processing, and a set of pointers to more reading. This could be used to frame our own CCE practice, as a set of considerations we might ask ourselves as we go about our own CCE design, in terms of what might provoke an unintended rejection stance in learners.

1. **We might feel conspiracy perceptions around economic and political power when we are faced with climate science-based behavioural asks.** Climate change facts are sometimes ignored, or even denied, because they are seen as conspiratorial, used by those in power to 'control carbon', which is seen as representative of wealth. George Marshall's book, *Don't Even Think About it: Why our Brains are Wired to Ignore Climate Change* (Marshall, 2015), describes and explains the conspiracy perception response thoroughly and in an accessible way.
2. **We might perceive 'green politics' to pose a threat to economic growth.** Capitalism requires growth and, whether we like it or not, capitalism remains the economic framework that runs most societies, and it is one that learners will be familiar with through their humanities subject learning. Avoiding or halting climate change seems to threaten free-market thinking and to counter a capitalist 'growth mindset' because it can seem, to those who perceive 'equitable to others' as 'unfair to me', to require a contraction of resource use. Naomi Klein's book, *This Changes Everything: Capitalism vs. the Climate* (Klein, 2014) is a great introduction to the economic threat perception response to climate facts. This response often comes from a place of personal fear that an environmental outlook and a wish to accrue wealth are incompatible. The view of 'eco-capitalism' as equalling a politics of 'no growth' (Blühdorn, 2018) can be highly problematic to certain demographics.
3. **We might feel apathy to something that we perceive as a distant threat in terms of our personal risk perceptions.** Psychologists have explained social apathy to climate science in exploring how we process threat and risk. Climate changes slowly enough not to trigger our emergency response and, for a long time, climate scientists tended to use images that were very hard for most of us to relate to when they represented the threat of climate change. It is very unlikely that any of our learners have seen a polar bear in the wild, standing on a shrinking iceberg. It is, however, very likely that all of our learners have heard their family or carer discussing the cost-of-living crisis. So, which one of those threats is the closest? The climate crisis is a threat perceived to be distant. We are more likely to feel aversion to short-term loss over responsibility to tackle long-term risks. Robert Gifford describes this phenomenon as one of the '*dragons of inaction*' (Gifford, 2011): psychological barriers that explain the disconnect between widespread knowledge and concern about the environment and the weak public response around climate action.

4. **We all experience politically, or directionally, motivated reasoning (DMR) when faced with contentious topics.** Rejection of climate action can be motivated by our political and cultural views, often subconsciously. DMR profoundly affects humans' cognitive processing of facts, and gives rise to biased reasoning driven by our personal goals and needs. Political, or directionally, motivated reasoning is the tendency we have as individuals to reject new data, information or facts if they contradict our existing belief system (Druckman and McGrath, 2019). Motivated reasoning is a sensible psychological option for the human mind. We evolved as social primates for whom a sense of belonging is important for survival, so it is understandable that we evolved to prioritise feeling part of a group. DMR has been found, however, to work strongly against the convergence of public opinion on factually accurate beliefs around contentious issues. Professor Dan Kahan introduces how politically motivated reasoning impacts climate communication (Kahan, 2012, 2017) and highlights that individuals become entrenched in politically motivated views when faced with facts that require a change of their standing. Our attitude to environmental and climate policies have become a shorthand for who we are, and, even from a very young age, learners are aware of the climate views of 'people like me'.
5. **We might feel more comfortable blaming others for causing climate change.** This is the rejection response. Socio-political rejection arguments are often associated with 'othering' the problem of climate change. What, we might feel, is the point in a national effort to reduce emissions, or of causing ourselves sufferance, if others (other demographics or other nations) are seen to be 'the problem'. 'Othering' is associated with a view that rapidly developing nations are responsible for the highest levels of emissions, which is not true when we consider the cumulative emissions of nations over time as a function of their population size. When per capita historical emissions are considered, the United States of America, Canada, Australia, and the United Kingdom are all among the top ten highest emitters (Carbon Brief, 2021).
6. **We might fear climate change, as a fundamental threat to our view of the world as orderly and stable, so much that it is easier to reject the very idea of it.** Matthew Feinberg and Robb Willer (2011) published two experiments exploring whether strongly worded messaging on how serious the threat of climate change is could be counterproductive in part because of how the dire risk of climate chaos can, to some, feel like it threatens our need to believe the world is fair, ordered and safe. Psychological research shows that lots of people need to perceive the world in this way and struggle with evidence that climate change will not impact the world in a just way. Feinberg and Willer's research showed that, for a lot of people, discounting evidence for 'climate chaos' is more comfortable because accepting it would require rejection of our view of a stable, just and orderly world. We may choose to deny evidence rather than accept the threat to how we see the world.

Consideration of the works mentioned above, and their theses, can help us to share with learners, via our CCE practice, how society's lack of action on climate change is not simply explained by a denial of climate facts but by the challenges of confronting difficult feelings when faced with evidence of an existential threat such as the global climate emergency. Most members of the public agree that our climate is changing but that does not equate to an acceptance that it is caused by humans, of the need for climate action to limit that change, or of what form that action should take. It can be a useful exercise to work through this literature and think of ways to share overviews with learners in an accessible way. A simple class exercise with older learners might ask groups to come up with a counter-factual to each position above. For example, studying lived experiences of flooding and extreme weather events might be a counter-factual to the position of perceived distance between the individual and the threat of climate change.

An added benefit of the work educators already do to encourage scientific curiosity might be to also offset directionally motivated reasoning and encourage the processing of climate facts with the goal of accuracy.

We might ask ourselves, however, is there still a time and place for deficit-approach delivery in our CCE? Who does it 'work' with? If an audience's DMR is in line with the acceptance that human activity has caused climate change, they are probably already taking climate action, and they are likely to take on board additional deficit-approach climate communication. However, to meet our climate goals we need action in those whose DMR would cause them to reject deficit-approach climate communication because it contradicts their standing beliefs that human action is not the cause of climate change. In those individuals, 'more climate knowledge' is unlikely to promote behavioural change. However, not all hope is lost for our fact-based CCE delivery. In exploring how an audience's motivation impacted their engagement with climate-communication political scientists, James Druckman and Mary McGrath (2019) found that audiences tend to fall into two categories in terms of knowledge motivation: those who are motivated by belief-protective reasoning and those who strive for accuracy in interpreting knowledge. With the second group, deficit-approach 'climate fact' delivery might be a reasonable component of CCE, if one is mindful that what the climate communicator considers to be credible and accurate information sources may not be what the audience considers credible and accurate. Other authors (Bolsen, Druckman and Cook, 2014) have found that an 'accuracy goal' can be induced even in belief-motivated thinkers if they are explicitly encouraged to form an accurate opinion, to consider alternative perspectives to their own and to be prepared to explain the reasons for their conclusions to others. It would seem that encouragement to think critically, to assess accuracy and to explain how a view was arrived at encourages accuracy-motivated, not belief-motivated, thinking. This might be relatively new to political scientists seeking to understand public reasoning but, fortunately, asking learners to explain their thinking and take the views of others into consideration, is already commonplace in classrooms and lecture rooms and is probably doing good work to guard against DMR around climate facts.

Inviting people to express their social and political beliefs explicitly before considering climate evidence has also been found to be useful. Such evidence might lead us to wonder how this might be taken into consideration in CCE. Bronwyn Hayward (2020) argues that we should not avoid the sharing of standings and beliefs in CCE but rather invite learners to make a critical analysis of their own social and political positions on the environment, and those of others, and provide them with the language to tackle such complex issues. It seems that, in an education environment, giving learners space to explore beliefs and views, rather than imagining we are offering climate facts in a vacuum, is a more effective way of offering climate communication.

Where discussions around politics would be challenging in a learning environment, there are still options. A useful way in, often discussed by American climate scientist and communicator Dr Katharine Hayhoe, is to consider how climate change resonates with different communities and groups of people according to their passions and interests (rather than their political views). For example, an interest in a sport, hobby or recreation activity that is climate sensitive (e.g. football, fishing, sailing, or even travelling – Williams, 2017) can be a way in to discussing climate change in terms of things people are passionate about, rather than political standings.

In considering my own CCE practice, through the research lenses shared here, I find myself also thinking about the role of oracy in our CCE (Oracy Education Commission, 2024). Surely, if there is evidence that skills, such as critical thinking, balancing views and opinions, and justifying how we arrive at an accurate understanding of a contentious topic, are all vital to developing good climate understanding and inspiring climate action, then a skill that is critical to testing thought and debating important issues, in our polarised society, is also critical.

In Box 2, some of these ideas are expanded into suggested ways we might involve learners more directly in CCE.

Box 2 Learner-centred climate change communication examples

Background

Some climate science researchers argue that the disconnect between those who produce climate knowledge (scientists and governments) and those who have to use climate knowledge in their daily lives is impeding climate action (Howarth *et al.*, 2022). They suggest that more usable climate knowledge might be created if people worked in a more collaborative way to produce it. That might mean, for example, a local authority working with a fishing community from the start of a project to work out how climate change is going to impact marine wildlife and livelihoods and how to manage a fishery in the face of both sets of impacts. Learners can benefit from involvement in climate and environmental science via co-production as well. A knowledge-deficit approach to climate communication is not an effective way to engage all people in climate science, and science-communication theory also tells us that a collaborative approach, such as co-production of research, which involves those from outside scientific research communities in a project in an active way, can both improve the quality of science and support positive climate action across society.

Practice

Public climate and nature assemblies (e.g. www.climateassembly.uk) have become a popular way to actively involve people in climate science – broader deliberative democracy methods are well covered in the literature (Hayward, 2020). However, climate assemblies have been criticised as 'preaching to the converted', attracting participants who are already engaged in climate action, and being hard to deliver at scale, risking emphasising the elitism of participation in climate action. While not against people's climate assemblies, educators might also consider involving learners in active research on a local scale, allowing for tangible engagement and outcomes. A famous example of co-production of research with learners is the Blackawton School bee research project (Blackawton, *et al.*, 2011), in which pupils from a primary school in England found out that bumblebees use a combination of colour and spatial relationships in choosing which colour flowers to feed from. Their project was published by the Royal Society, with the school as lead author. If we take Dan Kahan's work around the idea that the scientifically curious display less directionally motivated reasoning (Kahan, 2017) when faced with facts on contentious topics, such as the climate and environmental issues, then projects like the Blackawton bees citizen science research, might have a positive outcome both on improving access to science capital and on making people less prone to DMR. Additional options for citizen science research projects can be found via the Institute of Research in Schools (https://researchinschools.org).

Example

One accessible way to access co-production opportunities is to work with science outreach providers at your local university. Under the auspices of the Swansea

University Science For Schools Scheme (https://s4scienceportal.co.uk), we delivered the co-production of a marine biology study. While participating in a 'touch tank' outreach day, local key stage 2 (age 7–11) participants asked '*Could a crab learn to use a maze to find food?*' Working with Swansea's marine biologists, a study was designed that found out, yes, crabs can learn to use a maze to find food. The data from the study now informs a local seagrass restoration project on how to protect seedlings from foraging by crabs. The author of this article, having published a piece of primary research (Davies *et al*., 2019) provoked by a year 6 class question, can vouch for the unique, enjoyable and rewarding process of co-producing scientific research with young people. Reaching out to university outreach providers to ask what opportunities exist for co-production, rather than knowledge-deficit climate outreach delivery, is a good way to find ways of actively involving learners in climate knowledge. School-delivered examples could also include things like local pollution-monitoring projects. Simple Sellotape/Vaseline patches (with younger learners) or microcontrollers as environmental sensors (with older learners) can be used to monitor the area around school for particulate-pollution hot spots. For more of a nature angle, younger learners could deploy 'bug hotels' around school and monitor usage, storing and disseminating the results via a local *iNaturalist* site (e.g. https://uk.inaturalist.org in the UK).

CCE will achieve the most if we do not assume filling a knowledge gap will inspire action in all, and if we do not imagine climate science is processed in a political, social, belief or values vacuum. These might seem obvious points, but the degree to which social and political views, values and beliefs affect our processing of factual information on contentious topics such as climate change is, in my experience, commonly glossed over in the broader climate-communication field. If anything, early works around CCE were more aware of this paradox (Cutter-Mackenzie and Rousell, 2019) than climate scientists working in climate-communication space are now. However, knowledge-deficit embedded CCE work is still prevalent (Leite, 2024).

In addition to the ideas set out in Box 2 there is much to be learned from stepping away entirely from a science-based approach to climate communication and exploring the climate emergency through arts and creative lenses. Such endeavours are covered in a significant new and emerging literature base of its own (Bentz, 2020) but I would also highlight a recent example from the UK arts community. In my experience, learners across science and humanities subjects are fascinated by the annual climate COP meetings, not least because the very name is both intriguing and confusing, COP, standing for the Conference of the Parties – the Parties being the signatories to the United Nations Framework Convention on Climate Change, more commonly understood as the group of nations who sign things like the Paris Climate Agreement. While we might imagine the world of global climate treaty politics to be dull and riddled with minutiae likely to bore learners, for reasons I do not claim to understand it is my experience that they are rather fascinated by the COP meetings and eagerly engage with opportunities to learn about them. For those wishing to study them, the origin story of our global attempt to find consensus around halting climate change through the COPs has been written into a recent play, *Kyoto* (Robertson and Murphy, 2024), which tells the story of the 1997 Kyoto Protocol negotiations as a political thriller. While not suitable for younger learners, it is a great example of what a fabulous lens the arts and creative practices are for exploring the great climate problem with children and young adults.

Conclusions

Action to tackle climate change has been frustratingly slow to gain momentum and young people are among the most passionate voices arguing for society to do better. However, climate issues also have to be communicated, in our classrooms, against a background in which action on, and even belief in, climate science, is politically polarised and a source of constant conflict in the media and online. I have tried to set out in this article the evidence that our views on climate science are entangled in our social and political views and beliefs. On the basis of that evidence, assuming that filling a knowledge gap is all that is needed to uniformly inspire action on climate does not hold up when it comes to the wider public, and we should assume the same is true with learners.

There is evidence that if we share factual climate information to encourage climate action, assuming that we are doing so in a vacuum of personal political beliefs and values, we do not reach hearts and minds evenly or equally. This so-called 'knowledge-deficit approach' to teaching science has been favoured for many decades, underpinned by the notion that more information creates wise and informed scientific decision-makers. Climate science itself has often argued from that position. However, the political and neuro sciences tell us that DMR, our social and cultural instincts about what is right and wrong for 'people like me' to think, and a suite of value-based judgements around risk perceptions, strongly inform our information processing around climate issues.

Some examples have been shared of learner-centred climate communication tools, which give space to recognise the difference between climate science and climate politics (see Table 1). Many of the experiences and examples I have shared come from the delivery of a ten-year STEM outreach programme, the Swansea University Science for Schools Scheme, the outreach materials of which are freely available on an open-access platform (https://s4scienceportal.co.uk). It is my hope that sharing pointers to some of the key literature and sources with educators looking to bring climate change communication and education into their classrooms, offers ways to do so through an understanding that a belief-centred, and not just an evidence-centred, response to scientific climate facts is in control when we share CCE with learners.

Whatever else it does, CCE should be underpinned by understanding that society's present failures to take climate action at scale are not the result of a deficit in knowledge. Best practice in both broader climate communication and classroom-based education needs to take account of, respect and recognise learners' beliefs and feelings, and not just share factual knowledge in the hope of inspiring action in all.

Table 1 A simple example breakdown of topics that we might cover under a climate-science communication methodology and those that fall more into climate politics

Climate science/climate factual information that could comfortably be presented from a 'knowledge deficit' position	Climate politics topics that should give space for learners to consider and express their directionally motivated reasoning, SEEDS positions, and belief systems
• the greenhouse effect • the Earth's long-term temperature history • the physical scientific basis of climate change (e.g. asymmetric greenhouse gas molecules and the absorption of outgoing infrared radiation) • albedo, the Earth–Sun relationship over time, Milankovitch theory, glacial–interglacial cycles • recent, forced, natural climate anomalies (e.g. the Little Ice Age, phases of solar activity anomaly or periods of large, frequent volcanic eruptions) and their distinction from modern, human-caused climate change	• the energy transition, renewable energy, nuclear, etc. • emissions budgeting – e.g. carbon trading • climate finance • green infrastructure • food, diets and greenhouse gas emissions • land-use change • just transition and net zero politics • loss and damage funding • offsetting (e.g. tree planting to offset emissions)
Assumptions that we might invite learners to consider before teaching around climate science topics: • There is a physical, scientific basis, and evidence, underpinning our understanding of human-caused climate change. • The Earth's long-term temperature thermostat is the greenhouse effect and its response to the long-term carbon cycle. This greenhouse effect has been enhanced by human-caused greenhouse gas emissions, which have disrupted the carbon cycle, and by land-use change. • Natural and human-caused climate change can be distinguished; the signature of the latter is the fast, unidirectional pace of change in the Earth's average temperature. • Personal beliefs and standings should not influence our interpretation of climate facts, but they often do.	*Assumptions that we can invite learners to consider before teaching around climate politics topics:* • The impacts of climate change will not be the same for all people; some societies, and some demographics, are more vulnerable to climate change impacts than others. • Climate change impacts and inequality are intertwined grand challenges. • Disadvantaged groups suffer disproportionate loss of income and assets under climate change. • Our personal standings and beliefs influence our decision-making on climate action. • Personal experiences influence our feelings, beliefs and views on climate politics and decision-making and it is useful and valid to acknowledge our views, and those of others.

(Separating topics out like this can help us, as educators, to be guided in the methods we employ for different topics, and to support learners to be encouraged to critically engage with complex climate topics. See Hayward, 2021, for an explanation of SEEDS (Social agency, Environmental Education, Embedded justice, Decentred deliberation and Self-transcendence) theories around environmental citizenship.)

Key messages for delivering effective climate change education

- Begin the design process for any piece of CCE, or public engagement, remembering that directionally motivated reasoning is a universal human trait. As individuals, we reject new information that contradicts our standing beliefs. The greatest counter to this is to give audiences and learners the opportunity to express and explore their own and others' standing beliefs as part of the climate-communication practice.
- Be clear on when we are sharing climate facts and scientific evidence and when we are stepping into climate politics space, where personal standings become even more influential over reasoning.
- Be clear that climate-science denial is not welcome in climate-education space – and have myth-busting facts on standby to counter it – but remember that even very young learners can, and should, be encouraged to express value-based views on things like energy politics, nature and inequality around climate change. Stepping into climate politics can be really valuable, but clarity should be given to any audience about the difference between the two types of communication: climate-science based and climate-politics based. Table 1 differentiates some ideas around this.
- Remember that most of the research done around how audiences engage with climate change knowledge is based on adults. Ironically, we need to look outside climate communication and climate science, for tools that can help us with climate change education. Try systems like the SEEDS model of citizenship education, which focuses on: Social agency, Environmental education, Embedded justice, Decentred deliberation, and Self-transcendence.

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