



Education and climate change

Learning to act for people and planet



13 CLIMATE ACTION



GLOBAL EDUCATION MONITORING REPORT

2024

Education and climate change

LEARNING TO ACT FOR PEOPLE AND PLANET

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Photography caption: On September 28, 2023, in Quiche, Guatemala an eight year old indigenous girl holds a tree outside their home.

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The Education 2030 Incheon Declaration and Framework for Action specifies that the mandate of the *Global Education Monitoring Report* is to be 'the mechanism for monitoring and reporting on SDG 4 and on education in the other SDGs' with the responsibility to 'report on the implementation of national and international strategies to help hold all relevant partners to account for their commitments as part of the overall SDG follow-up and review'. It is prepared by an independent team hosted by UNESCO.

The *Global Education Monitoring Report* team is responsible for the choice and the presentation of the facts contained in this book and for the opinions expressed therein, which are not necessarily those of UNESCO and do not commit the Organization. Overall responsibility for the views and opinions expressed in the report is taken by its Director.

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Short summary

How can education lead to climate change action?

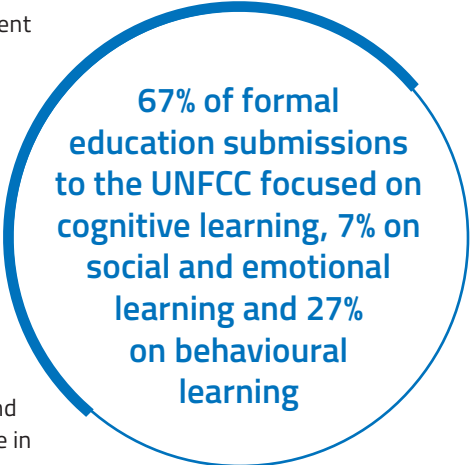
Despite strong evidence on the impact of education on other development outcomes and the role it plays in developing professional capacity for sustainable development transitions, education is often absent from other sectors' strategic, policy, planning and financing considerations. The *Global Education Monitoring Report* is introducing a new series to advance dialogue on the interrelationship of education with the other Sustainable Development Goals.

The first paper in the series focuses on climate change. It starts by reviewing the growing impact of climate change on education before turning to the role of education in climate action. Education has a somewhat underappreciated contribution to developing professional capacities for the transition to a green economy. Formal, non-formal and informal learning are also commonly believed to be playing a critical role in motivating actions on climate change mitigation and adaptation.

Yet a positive association between education attainment and unsustainable consumption levels, as well as inconclusiveness of much research on the direct impact of education on climate change adaptation and mitigation actions has in part contributed to education receiving low priority in global and national climate change agendas.

This paper argues that climate change education needs to adapt to fulfil its potential. The education paradigm cannot rely solely on knowledge transfer but needs to focus on social and emotional, and action-oriented learning.

Much of the research has focused on the impact of education attainment and cognitive learning. More research is therefore needed to assess other drivers through which education can influence behaviours and motivate climate change action. Such research is needed to formulate viable education reform packages that improve the curriculum, strengthen climate-readiness of schools and education systems, engage learners and prepare educators accordingly.



67% of formal education submissions to the UNFCC focused on cognitive learning, 7% on social and emotional learning and 27% on behavioural learning



"Since wars begin in the minds of men and women, it is in the minds of men and women that the defenses of peace must be constructed"

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Contents

Climate change and education are interlinked 1

Climate change is disrupting education systems and outcomes 3

Formal education needs to transform to advance climate change mitigation and adaptation..... 4

 Climate change education policy efforts are increasing – but remain insufficient.....4

 Education tends to improve knowledge, attitudes and resilience – but not enough..... 6

 Action-oriented pedagogy is needed..... 11

Formal education develops skills for climate change mitigation and adaptation 17

Students and youth are advocating for a broad vision of climate change education.....21

Informal education through communication and incentives is a vital tool22

 General communication campaigns need to be sensitive to context 22

 Targeted communication campaigns accompanied by incentives influence behaviour 25

Monitoring and evaluation of climate change education needs to be fit for purpose.....25

 It is time to propose a framework for a new indicator on green curricula..... 27

Recommendations31

References can be downloaded at the following link:
<https://bit.ly/ccec2024-ref>

Key messages

- **Education's role in combating climate change is not given the space it deserves in international education agendas.** SDG 4 was addressed in only 2 of 72 transnational climate initiatives.

- **Curriculum content needs to be monitored to better understand country efforts on climate change education.** This report proposes a new indicator on green content, based on national curriculum frameworks and syllabi.

- **Climate change curriculum content is not balanced.** About 50% of the maximum possible score was reached by 76 countries analysed in terms of green curriculum content across grades 3, 6 and 9. The score dropped to only 12% for words related to 'biodiversity' and 21% for those related to 'climate change'. Less green content is found in grade 3 than in grade 9 and in social science than in science syllabi.

- **Education systems tend to focus on imparting climate change knowledge.** In primary education, an assessment of how climate change has been included in submissions to the United Nations Framework Convention on Climate Change found that 67% of countries focused on cognitive learning, 7% on social and emotional learning, and 27% on behavioural learning.

- **A higher level of education tends to be associated with a higher probability to engage in adaptation action.** In the Khyber Pakhtunkhwa province of Pakistan, farmers with at least lower secondary education were more likely than less educated farmers to diversify crops, alter their crop calendars and use farm insurance to cope with the negative effects of climate change.

- **A higher level of education does not appear on its own to motivate mitigation action.** Analysis of Facebook users in 2022 shows that those with lower, upper and post-secondary education were almost equally likely to report they were 'participating in a group working to convince leaders to take action'.

- **Education can mitigate climate change indirectly through its impact on demographic growth.** In Bangladesh, the introduction of a female secondary school stipend programme in 1994 increased the years of education for eligible girls by up to 25%, delayed their marriage, and was the most significant driver of reduction in childbearing between 1993 to 2014.

- **Multiple sectors rely upon formal, non-formal and informal education to increase capacity for climate change adaptation and mitigation,** from energy to agriculture and forestry to urban planning. In a survey of some 12,500 businesses in the European Union, more than 80% believed that skills shortage was preventing climate change projects from advancing.

- **Students and youth are calling for improved climate change education.** They are calling for more context to understand climate change and justice history and highlighting textbook inadequacies. Many protests focus on university policies. In the United States, students have pushed 141 institutions to divest endowments from industries producing fossil fuels since 2012.

- **Campaigns around climate change aim to raise awareness among adults.** An analysis of climate actions taken by 96 cities with over 650 million inhabitants found that awareness and educational campaigns were the third-most common action taken by cities to combat climate change.

- **Climate change-related disasters disrupt education.** Over the past 20 years, schools were closed as a result of at least 75% of the extreme weather events impacting 5 million people or more in low- and middle-income countries.

Climate change and its impacts, pose an existential threat, as successive reports of the Intergovernmental Panel for Climate Change have testified. Responses are needed at multiple levels across sectors to adapt to current and future effects and, more essentially, to mitigate growing threats to people and planet. There is scope for mitigation and adaptation through changes in transport, energy, food and agricultural systems – and through the radical transformation of how economies and societies function, beyond incremental steps. Four agendas for action – the Paris Agreement, the 2030 Agenda for Sustainable Development, the United Nations Framework Convention on Climate Change (UNFCCC) and the Sendai Framework for Disaster Risk Reduction – collectively provide globally agreed-upon frameworks for climate action.

Education receives some policy attention in these global frameworks. Article 6 of the UNFCCC outlines six priority areas of Action for Climate Empowerment: education, training, public awareness, public participation, public access to information and international cooperation (UNESCO and UNFCCC, 2016). These are also mentioned in Article 12 of the Paris Agreement. The 2030 Agenda for Sustainable Development includes education (SDG 4), sustainable consumption and production (SDG 12) and climate change (SDG 13) goals. A lot of the activity focuses on the Conference of Parties (COP), the main decision-making meeting of the UNFCCC. Since COP26 in Glasgow in 2021, the education community has accelerated its efforts to highlight the importance of education and engage with other sectors, which have culminated in the endorsement of the Declaration of the Common Agenda for Education and Climate Change by 41 founding partners in COP28 in Dubai in 2023. Nevertheless, education remains largely underemphasized in broader climate change policy discussions. As a result, it features inadequately in implementation and financing plans.

This policy paper aims to bring the education and climate change communities closer together. It highlights the evidence on the role of education in developing knowledge, attitudes and capacity for climate change action, and analyses formal, non-formal and informal learning policies and interventions. It also draws on 80 country profiles that provide overarching analyses of laws, policies and strategies on climate change communication and education, developed in partnership between the Global Education Monitoring (GEM) Report and the Monitoring and Evaluating Climate

Communication and Education (MECCE) Project. Recommendations are provided on how education can play a greater role in combating climate change.

CLIMATE CHANGE AND EDUCATION ARE INTERLINKED

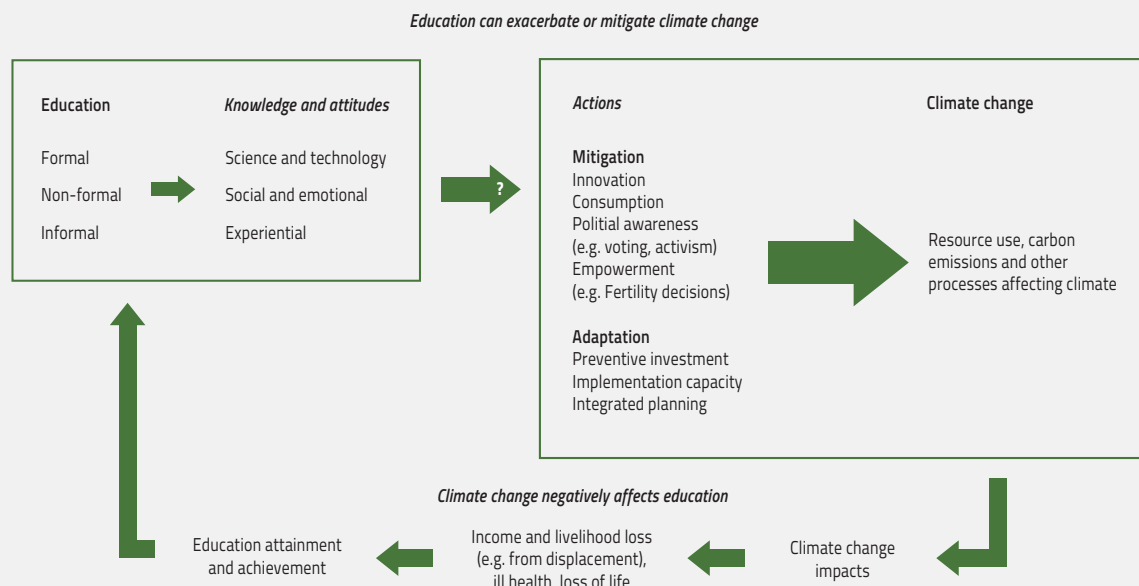
Climate change disrupts education, while education can shape the human potential for climate change adaptation or mitigation in several ways (Figure 1). Climate change-related impacts are already disrupting education systems and outcomes. Direct effects include the destruction of education infrastructure as well as injuries and loss of life among students, parents and school staff. Climate change has a negative impact on education indirectly through its displacement of people and the effects on people's livelihoods and health. These are not neutral. Impacts are greater on marginalized populations.

Conversely, education, whether formal, non-formal or informal, is key to climate change mitigation and adaptation efforts. The aims of climate change education often include improving knowledge; raising awareness; and changing attitudes, beliefs and behaviours. In the case of mitigation, education systems can also support climate-focused research and development, to accelerate technological innovation for climate solutions, and workforce capacity development through green upskilling, to implement transformative plans. Another powerful way education can help mitigate climate change is through increasing girls' educational attainment, which increases their autonomy over fertility-related decisions and reduces population growth (Lutz, 2023; UNESCO, 2016a).

In the case of adaptation, education is a key element of climate-related disaster preparedness aimed at reducing vulnerability (Pal et al., 2023). A well-designed curriculum, appropriate pedagogy and learning resources can prepare people to take complex, adaptive decisions (Feinstein and Mach, 2020), for instance in agriculture and construction. Education can empower vulnerable communities to adapt and be resilient in the face of climate threats, for example through empowering girls and women (Kwauk, 2021; Kwauk et al., 2022).

Education also has the potential to empower youth and adults as agents of change to mobilize their communities and change social norms. Young people are a significant voice and face of the climate change movement, highlighting issues of climate justice, such

FIGURE 1:
The role of education in addressing climate change is critical, but not sufficiently mobilized



Source: GEM Report team.

as racial justice, gender equality and indigenous rights (Xu and Iyengar, 2023), and the need for climate change education of high quality (UNESCO, 2022). Formal education on climate change can equip young people with the tools to understand the long-lasting impact of past behaviours and advocate for policy change at the local, national and global levels (COY17 and YOUNGO, 2022). Indigenous peoples also inspire the climate change movement, highlighting the challenge posed by rich countries' consumption and production modes, and leading by example, such as through traditional natural resource management practices (UNESCO, 2016; Karsgaard and Shultz, 2022).

However, inversely, higher levels of educational attainment are fuelling climate change. Countries with higher education levels tend to also have higher income and consumption levels and thus higher greenhouse gas carbon emissions per capita. This calls into question education systems, which have privileged an individualistic approach and have underemphasized the need for learners to live responsibly and respectfully on the planet (Karsgaard and Shultz, 2022). Rapid growth in educational attainment levels and the resulting growth in economic activity is expected to result in a 5-25% increase in greenhouse gas emissions by 2100,

depending on the region (O'Neill et al., 2020). To address this major challenge, more attention needs to be paid to holistic climate change education and communication.

Translating increased knowledge and awareness into individual behavioural change and collective action is not a simple task. Climate change education has traditionally used a knowledge transfer approach that focuses on teaching climate science, assuming that citizens who understand the science will be motivated and able to take climate action. After decades of this approach, it is evident that this traditional, cognitive, science-focused model is insufficient to spur the level of climate action required.

Overcoming psychosocial factors that thwart action, such as feeling grief, anxiety and powerlessness, needs to be taken into account in education design (Hickman et al., 2021; Hargis et al., 2021). Action-based, experiential and collaborative learning is key in this. Education and communication interventions also need to be responsive and targeted to diverse individuals, communities and industries.

CLIMATE CHANGE IS DISRUPTING EDUCATION SYSTEMS AND OUTCOMES

Climate related stressors, such as heat, wildfires, storms, floods, droughts, diseases and rising sea levels, affect education outcomes (Prentice et al., 2024). Climate change accelerates these challenges and has a direct impact on education and threatens to undo educational gains of recent decades (Sims, 2021). Most low- and middle-income countries are experiencing climate-related school closures every year, increasing chances of learning loss and dropout. Over the past 20 years, schools were closed in at least 75% of the extreme weather events, impacting 5 million people or more (Marin et al., 2024).

Increasingly frequent natural disasters, including floods and cyclones, have led to the deaths of students and teachers and have damaged and destroyed schools (Pal et al., 2023). Following the 2013 floods in Jakarta, access to schools was disrupted, schools were used as emergency shelters and some schools closed because of damage. Among schools surveyed, 81% of those with disaster management plans and a standard operating procedure for dealing with flood emergencies agreed that these were effective in times of crisis (Lassa et al., 2023).

In 2019, Cyclone Idai destroyed 3,400 classrooms and deprived 305,000 children of schooling in Mozambique (Gandidzanwa and Togo, 2021). School buildings are disproportionately impacted in the Pacific, which is extremely vulnerable to climate change-induced weather events and natural disasters. When Tropical Cyclone Gita hit Tonga in 2018, 72% of schools (but 35% of other buildings) were damaged. A 2021 assessment of over 6,000 school buildings in Samoa, Tonga and Vanuatu found that 50-90% of buildings may not withstand a strong cyclone or earthquake (World Bank, 2022). An analysis of the flooding risk for public schools across all 50 states in the United States found that over 6,300 public schools, or 7% of all schools, are located in flood zones (Pew Charitable Trust, 2017).

Exposure to heat has significant detrimental effects on children's educational outcomes. An analysis linking census and climate data in 29 countries between 1969 and 2012 showed that exposure to higher than average temperatures during the prenatal and early life period is associated with fewer years of schooling, especially in Southeast Asia. A child experiencing temperatures that are two standard

deviations above average is predicted to attain 1.5 fewer years of schooling than children experiencing average temperatures (Randell and Gray, 2019). High temperatures reduced high-stakes test performance in China and led to reductions in both high school graduation and college entrance rates (Park et al., 2020; Zivin et al., 2020). In the United States, without air conditioning, a school year hotter by 1°C reduced test scores by 1%. Very hot school days disproportionately impacted African American and Hispanic students, due to poor infrastructure conditions, accounting for roughly 5% of the racial achievement gap (Park et al., 2020). About half of public school districts need to update or replace multiple heating, ventilation and air conditioning systems (United States Government Accountability Office, 2020). In the most disadvantaged municipalities in Brazil, which were also amongst those most exposed to heat risk, students lost about 1% of learning per year due to rising temperatures (Marin et al., 2024).

Rain variability can be detrimental for education. An obvious effect is through floods: analysis of the 2010 flood on educational outcomes in Pakistan found that during the flood period, children and adolescents in the flooded districts were 4% less likely to be in school compared with peers in non-flooded districts (Ahmed et al., 2022). But there are also long-term, less visible effects. Analysis of Demographic and Health Survey data from 10 African countries shows that abnormally low precipitation has a negative impact on primary school completion. Six months of cumulative exposure to low precipitation and drought-like conditions decreased completion rates by 6.4% (Yang and Feng, 2023). In rural Maharashtra, India, drought reduced children's mathematics scores by 4.1% and reading scores by 2.7% (Joshi, 2019).

The impact of climate shocks experienced in early childhood can be long-lasting. Children in Ecuador exposed to severe El Niño floods in utero were shorter and scored lower on cognitive tests five or seven years later (Rosales-Rueda, 2018). In Indonesia, a longitudinal analysis from 1993 to 2015 showed that delays in the monsoon season during the prenatal period led to diminished height and weight among children aged 2 to 4, leading to acute malnutrition (Thiede and Gray, 2020). A study of rainfall shocks in utero over the first 15 years of life in India found that they negatively affected vocabulary at age 5 and mathematics and non-cognitive skills at age 15. The effects were more severe for boys and children of parents with a

lower educational attainment (Chang et al., 2022). An analysis of disasters experienced early in life by over 140,000 children in seven Asian countries found a negative association with school enrolment, especially for boys, and with mathematics performance, especially for girls, by the time they reach 13 to 14 years (Zhang et al., 2024). A longitudinal analysis of the effects of the 1997 wildfires in Indonesia found that they were associated with reduced years of schooling completed (Lo Bue, 2019).

Climate-induced education vulnerability is worse for marginalized populations. Of the 10 countries most affected by extreme weather events in 2019, 8 were low- or lower-middle-income countries (Eckstein et al., 2021). Of the 33 countries identified as bearing extremely high climate risks for children, where nearly 1 billion people live, 29 are also considered to be fragile states (UNICEF, 2021). In the United States, those with low income or without a secondary school certificate are 15% more likely to live in areas with the highest projected increases in childhood asthma diagnoses due to climate-driven increases in particulate air pollution (EPA, 2021). School districts in the United States that received federal disaster recovery funds had higher proportions of students from socially vulnerable groups (US Government Accountability Office, 2022).

Indirectly, climate vulnerability leads to loss of household income and less access to credit for farmers, which negatively affects their coping strategies, including investment in education (Kwauk et al., 2022). Flood exposure reduced the number of completed grades of 12- to 15-year-olds in Ethiopia (by 3.4%), India (by 3.8%) and Viet Nam (by 1.8%), as a result of household income loss (Nguyen and Pham, 2018). In Ethiopia, one additional environmental shock leads to more than one extra hour of child labour per week (Koochi-Kamali and Roy, 2021). In a survey of 15,000 youth in South Asia, 13% reported that climate change had affected their family's ability to afford schooling (UNICEF ROSA, 2020). Analysis from eight villages in coastal Bangladesh found that more than two thirds of those surveyed had encountered at least one natural disaster before marriage and these shocks were positively associated with the incidence of child marriage (Asadullah et al., 2021).

Climate change increases the likelihood of displacement and is one of the reasons why internal displacement has reached the highest levels on record. During 2022, 32.6 million were internally displaced due to disasters

(IDMC, 2023). Analysis of five countries – Bangladesh, India, Indonesia, Tuvalu and Viet Nam – finds five displacement patterns: temporary displacement, permanent migration to urban settlements, government-planned relocation, cross-border migration and trapped populations. These displacement scenarios lead to different barriers to education, related to a lack of financial resources, documentation or residency requirements (UNESCO and UNU-IAS, 2023).

Dealing with direct and indirect effects of climate change-induced disruptions requires a comprehensive focus on climate adaptation, including multisectoral planning, curriculum reform, teacher training and community awareness and engagement. One of the critical adaptation needs is resilient education infrastructure (**Box 1**).

FORMAL EDUCATION NEEDS TO TRANSFORM TO ADVANCE CLIMATE CHANGE MITIGATION AND ADAPTATION

Education throughout life is a tool that can address climate change challenges and the transition to a green, economy through building necessary skills and knowledge, improving critical thinking, and encouraging behavioural change for adaptation and mitigation (Ehlers et al., 2022). Education contributes to mitigation through training professionals. But there is often little evidence of its anticipated impact through other channels. For such objectives to be achieved, it is necessary to reconsider how education is delivered, conceive education as an activity that also takes place beyond school and integrate education efforts with the work of other sectors.

CLIMATE CHANGE EDUCATION POLICY EFFORTS ARE INCREASING – BUT REMAIN INSUFFICIENT

Nearly all countries have laws, policies or plans that address climate change in primary and secondary education (UNESCO and MECCE, 2023). Several countries have developed strategies that articulate a concrete education vision for climate change knowledge, awareness and actions (Kwauk, 2022; McKenzie, 2021). In England, United Kingdom, the Department for Education launched its Sustainability and Climate Change strategy in 2022, which includes plans to accelerate the roll-out of carbon literacy training to support at least one sustainability lead in every school, college and university; a new secondary school natural history course; and new requirements for sustainability

BOX 1:**Climate-resilient education infrastructure needs to be prioritized**

There are increasing calls to improve the ability of school infrastructure to absorb shocks and adapt to stresses and changes brought about by climate change impacts. The Comprehensive School Safety Framework 2022–2030 (CSSF) focuses on strengthening system-level resilience from all types of hazards, including those induced by climate (GADRRRES, 2022). The Global Program for Safer Schools, funded by the Global Facility for Disaster Reduction and Recovery, provides guidance for designing intervention strategies and investment plans (World Bank, 2023). Investments should protect classrooms from heat, make sure new buildings are constructed in low-risk areas, and utilize best practices to be resilient (Marin et al., 2024).

Indonesia has adopted and implemented the Comprehensive School Safety Framework in over 35,000 schools with multisectoral collaboration, which has heightened awareness of disaster risks; climate change impacts; and preparedness among students, teachers and communities (GADRRRES, 2023). In Mozambique, the education and public works ministries issued a decree in 2021 to ensure that all existing and new schools comply with resilience standards to respond to climate change (UN Habitat, 2022). In Rwanda, over 1,300 school sites were protected by temporary, retaining walls to mitigate landslides and risks to neighbouring communities (World Bank, 2022).

However, planning and funding for climate impact risks and adaptation remain inadequate (Global Partnership for Education, 2023; MacEwen et al., 2022). Analysis of country submissions for the midterm review of the Sendai Framework for Disaster Risk Reduction found risk levels are rising much faster than the resilience of the education sector in most countries, despite recognition that disaster risk resilience is key for preventing hazards from becoming disasters (GADRRRES, 2023). Yet awareness is low. In a recent survey of 94 education policymakers in 28 low- and middle-income countries, only about half believed that hotter temperatures inhibited learning. About 61% viewed climate change among the bottom 3 out of 10 priorities in education (Marin et al., 2024).

The lack of a climate resilience focus in infrastructure is not exclusively an education sector issue. An analysis of more than 4,000 infrastructure projects in 2019–20 found that climate resilience was a very small fraction of total infrastructure investment in the water, waste water, transport, energy, agriculture, forestry and land-use sectors. For every USD 1 spent on climate-resilient infrastructure, USD 87 was spent on infrastructure projects that did not integrate climate resilience principles (Padmanabhi et al., 2022).

teaching (Department for Education, 2023). In the United States, with some exceptions, state standards and curriculum frameworks generally do not have a holistic approach to climate change, but instead focus on cognitive learning (MECCE and NAAEE, 2022). In 2020, New Jersey became the first state in the country to include climate change in multiple subjects, including art, social studies and physical education, under the leadership of the First Lady of the State (New Jersey Department of Education, 2020). The state government has allocated USD 4.5 million to support climate change education school grants in 2023 (Yaple, 2023).

However, climate change education ambitions are generally not sufficient. An analysis of national climate action plans to reduce greenhouse gas emissions and adapt to the impacts of climate change showed that countries fell short on six metrics defined by Education International: policy ambition, extent of

integration, inclusion of relevant stakeholders, quality of climate change education, climate justice and system strengthening (Kwauk, 2022). In a separate analysis, among 80 countries, only 30% had publicly available climate change education budgets (UNESCO and MECCE, 2023). A review of 39 education systems in Europe found that, while they have all embedded sustainability in their curriculum, capturing competences such as promoting nature, political agency, individual and collective action and systems thinking, envisaged activities are not adequately supported. About half of the systems set sustainability related objectives in teacher education programmes and only one third provide financial support for small-scale infrastructure or relevant field trips (European Commission/EACEA/Eurydice, 2024).

Even where budget allocations have been recorded – a possible sign of commitment – they may be inadequate

to implement ambitious policies. In Ethiopia, USD 2 million was allocated to the Climate Change Education Strategy (2017-2030) to fund primary school climate change materials, provide training to primary and secondary school teachers, and monitor and evaluate the strategy's implementation. However, at the beginning of the plan, the environment ministry had not confirmed budget availability for the teaching and learning resources, and a general lack of rigorous resource mobilization activities was recognized (Ethiopia Ministry of Environment, Forest and Climate Change, 2017). In Zambia, USD 9.1 million was estimated as necessary to mainstream climate change learning into national priority sector policies and systems, for example through curriculum review, which is a tiny fraction of funds received through the major climate financing channels (Yila, 2021; Zambia Ministry of Land and Natural Resources, 2021).

EDUCATION TENDS TO IMPROVE KNOWLEDGE, ATTITUDES AND RESILIENCE – BUT NOT ENOUGH

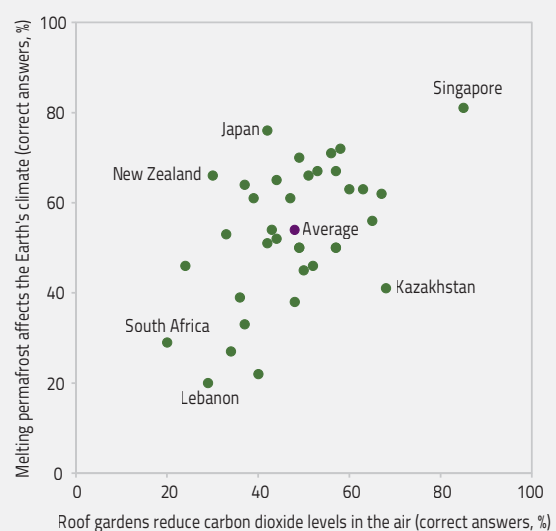
Large-scale surveys tend to highlight how climate change knowledge levels vary within countries by education attainment. Analysis of 2007–2008 Gallup World Poll data from 119 countries found that education level was the single strongest predictor of public awareness of climate change (Lee et al., 2015). Climate literacy – understanding one's influence on climate and its influence on individuals and society – plays a pivotal role in people's responses to climate change and is strongly associated with education. In China, a nationwide survey found that education and online media exposure are significantly associated with climate literacy (Pan et al., 2023). According to the Afrobarometer public opinion survey in 33 countries, climate change literacy is positively associated with education, particularly tertiary education (Simpson et al., 2021).

Scientific knowledge is a critical dimension of climate change knowledge (OECD, 2021), for instance, awareness of greenhouse gases as a cause of climate change. However, it is not only differences between levels of education attainment that matter but also differences in education content at the same level of education attainment. The 2019 Trends in International Mathematics and Science Study (TIMSS) assessed a range of earth science, life science and biology questions, which covered issues such as conservation, ecosystems, pollution, climate change and nature cycles. Grade 8 student knowledge varied

considerably. For example, 20% of students in South Africa could answer a question on the role of roof gardens in reducing carbon dioxide levels in the air and 20% of students in Lebanon could answer a question on how the melting permafrost affects the Earth's climate compared to the more than 80% of students in Singapore who could answer both questions correctly (Figure 2) (Yin and Foy, 2020).

According to the 2018 Programme for International Student Assessment (PISA) study, students who attended schools that covered climate change were 12% more likely to be aware of this issue than those who attended schools where the topic was not covered. But even when climate change is covered in the curriculum, not all students learn what is expected. In Brazil, 86% of students go to schools where the principal reported there was a formal curriculum for climate change, but only 45% could explain how carbon-dioxide emissions affect global climate change (Figure 3). Overall, students were more likely to identify the long-term climate mitigation actions to address global warming, such as reducing greenhouse gas emissions, than the medium-term adaptation actions, such as building dams or sea walls as defences (OECD, 2022) (Box 2).

FIGURE 2:
Student scientific knowledge varies widely between countries
Percentage of grade 8 students who correctly answered questions related to the environment, 2019

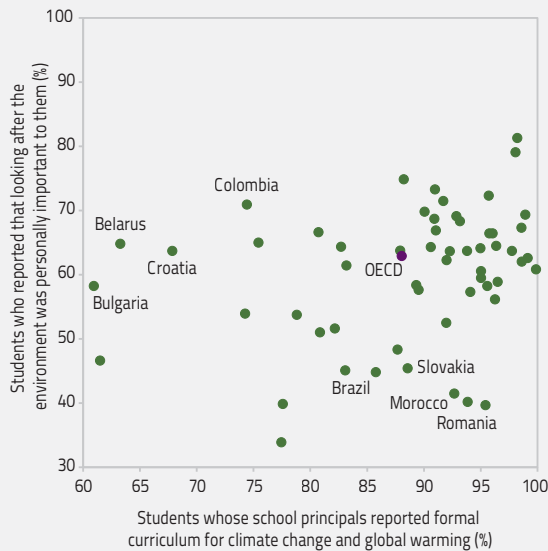


Source: GEM Report calculations based on the 2019 TIMSS.

FIGURE 3:

Most students are taught about climate change in school but their scientific knowledge varies

Coverage of climate change in the secondary school curriculum and 15-year-old students who can explain impact of carbon emissions on climate change, 2018

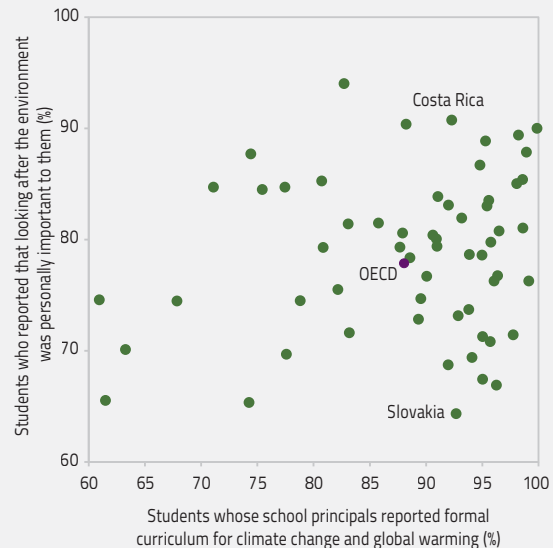


Source: GEM Report team calculations based on the 2018 PISA.

FIGURE 4:

Most students are taught about climate change in school in richer countries but their scientific knowledge and concern for the environment vary

Coverage of climate change in the secondary school curriculum and 15-year-old students' concern for the environment, 2018



Source: GEM Report team calculations based on the 2018 PISA.

A key mitigation channel, the impact of educational attainment on women's autonomy over childbearing decisions and its resulting effect on population growth, is often downplayed (Box 3).

More education is expected to increase the probability that people will express concern for the environment. Research has concluded that such concerns expressed in surveys are genuine and not subject to social desirability bias, in other words, that more educated respondents are more likely to give the 'right' answer even though it does not reflect their true opinion (Milfont, 2009). According to the 2019 World Risk Poll in 142 countries, those who had completed secondary or tertiary education were more concerned about climate change than those who had less than secondary education (de Bruin and Dugan, 2022). Public opinion polls of over 500,000 people from 50 countries found that individuals with post-secondary education were more likely than less educated peers to note that climate change was a global emergency. This group also expressed a higher level of support (58%) than the average respondent (42%) for 18 of the assessed climate policies, regardless

of age and gender (UNDP and University of Oxford, 2021). In India, a nationally representative survey found that more educated individuals were much more likely to be alarmed about the dangers of climate change, accept and understand global warming, perceive risks, and support climate and energy policies (Leiserowitz et al., 2023).

An analysis of climate change beliefs, attitudes, policy preferences and behaviours from a global sample of over 100,000 Facebook users in 2022 also found that more educated people were more likely to report having more knowledge about climate change and express more concern about its implications. They were also more likely to say that action on climate change should be a higher government priority, and that there should be more focus on renewable energy and less on fossil fuels, although the differences are not great (Table 1).

Other studies suggest that more educated people are generally more likely to link their concern for the environment with support for climate-oriented policies and to vote accordingly. Using compulsory schooling

BOX 2:**More formal education is linked to greater preparedness for climate change adaptation**

Those with higher levels of education have a higher capacity to adapt to climate change and a lower chance of suffering from its impact (O'Neill et al., 2020). Investment in universal primary and secondary education has been found to be the most cost-effective strategy to cope with uncertain climate dangers (Striessnig et al., 2013). Analysis carried out for the 2016 GEM Report examined how different rates of progress in education would affect the number of deaths from extreme climate events and other natural catastrophes, including storms, floods, droughts and landslides. The model used past information on the relationship between education and disaster deaths from the Emergency Events Database as a basis for forecasts of changes in disaster deaths in the coming decades. There were about 250,000 disaster-related deaths between 2000 and 2010. If trends in education continue at the current pace, but the frequency of natural disasters increases by 20%, the number of disaster-related deaths will remain at this high level to mid-century and beyond. If, however, the pace of education expansion quickens, and universal secondary education is achieved by 2030, then by 2040–50 there will be 10,000 to 20,000 fewer disaster-related deaths per decade at a constant disaster frequency, and 30,000 to 50,000 fewer deaths in a scenario of increased disaster frequency (UNESCO, 2016a).

Comparing hurricanes in Cuba, the Dominican Republic and Haiti showed that better education among the population reduced vulnerability in the short term through greater awareness of crucial information, faster and more efficient responses to alerts, and better post-disaster recuperation. However, there were also important long-term effects through the empowerment of women and the creation of social networks for mutual assistance (Pichler and Striessnig, 2013).

School inclusiveness also plays a role helping students adapt to climate change. In India, flooding episodes affected children's learning less when teachers were seen as fair and where there was stronger engagement between teachers and parents, especially those who were poor (Khalid et al., 2024).

Mothers with formal education are more likely to understand the risks associated with extreme weather, recognize warning signs and seek out information from reliable sources. Educated mothers better mitigate the impact of air pollution and extreme temperature on the risks of low birth weight and preterm birth (Liu et al. 2022; Hao et al. 2016). In 10 African countries, one additional month of exposure to abnormally low precipitation rates decreases the probability of completing primary school by 1.1% for poor households with a better educated mother but by 4.8% for all other households (Yang and Feng, 2023).

Farmers with more education adopt climate change adaptation practices. In rural India, fathers' education mitigates negative drought effects (Joshi, 2019). Adaptation strategies among potato farmers in Java, Indonesia, are positively affected by education, participation in farmers' groups and agricultural-related infrastructure (Purwanti et al., 2022). In Nicaragua, more educated coffee farmers are more confident in their own adaptive capacity (Quiroga et al., 2020). In Pakistan, interviews with 720 farm households in 6 districts of Khyber Pakhtunkhwa province found that farmers with at least lower secondary education were more likely to diversify crops, alter their crop calendars and use farm insurance to cope with the negative effects of climate change (Khan et al., 2020). In Limpopo province, South Africa, less educated farmers are more challenged to understand climate variability and plan for climatic adaption (Shikwambana and Malaza, 2022).

Education is also believed to have a positive impact on the non-agricultural economy. Educated individuals with decision-making authority are key influencers of local or national climate outcomes. In China, enterprises with highly educated chief executive officers (CEOs) are more likely to engage in innovation, especially when they face strict environmental pressures (Zhou et al., 2021). A panel analysis of listed companies from 2009 to 2019 found that CEOs with more education increased investment in environmental protection, especially in non-manufacturing industries (D. Wang et al., 2022). In Denmark, more educated CEOs were more likely to manage more energy-efficient firms (Amore et al., 2019). In Viet Nam, CEOs of small and medium enterprises are more likely to have positive corporate environmental performance (Tran and Pham, 2020).

BOX 3:**Education empowers women to make childbearing decisions**

While individuals in rich countries bear the main responsibility for climate change due to their unsustainable consumption and production patterns, rapid population growth in poor countries is also a growing challenge. The two main drivers increasing greenhouse gas emissions are increasing GDP per capita (by 2.3% per year between 2010 and 2019) and population growth (by 1.2% per year between 2010 and 2019) (Pathak et al., 2022).

Population planning is a sensitive issue, not least due to historically controversial population control programmes. It requires careful attention to context and a rights-based approach to universalizing access to sexual and reproductive health (Stephenson et al., 2010). Girls' education is a critical factor for reproductive planning. Education leads to delayed marriage and childbearing; higher participation in the labour force; improved health and reduced mortality of children; better knowledge, access and use of contraception; and improved autonomy over fertility decision making (Kim, 2023; Patterson et al., 2021; Snopkowski et al., 2016).

A systematic review of causal studies found that educational attainment was linked to a decline in fertility rates, indicating that more educated girls delay childbearing and/or plan longer spacing between children (Psaki et al., 2019). In Indonesia, one more year of education reduced the number of live births by 0.4 on average and increased contraception use by 10% (Samarakoon and Parinduri, 2015). In China, one more year of female education reduced the number of births by 0.24, and the effect was larger for rural women (Chen and Guo, 2022).

As a result, incentives to expand female education have resulted in reduced population growth. In Bangladesh, the introduction of a female secondary school stipend programme in 1994 increased the years of education for eligible girls by up to 25%. Girls were more likely to get married later and have fewer children. They demonstrated more autonomy in household and healthcare decision making and were more likely to work in the formal sector (Hahn et al., 2018). An analysis of seven rounds of the Demographic and Health Surveys conducted from 1993 to 2014 showed that female education was the most significant driver of decline in childbearing, above family planning indicators. The proportion of educated women in a community affected the decline in other education groups, implying a diffusion of learning from more educated to less educated women (Bora et al., 2023).

An analysis comparing global reductions in total fertility highlighted that the pace of fertility decline due to educational attainment is lower in sub-Saharan Africa, which may be a result of lower education quality or lack of expansion of formal labour market options. Still, attaining lower secondary education had the most important effect in accelerating fertility decline (Liu and Raftery, 2020). The importance of education for fertility decisions can also be seen when education progress stalls. An analysis of birth patterns of about 670,000 women born between 1950 and 1995 in 18 African countries found that if education progress had not stalled, it would have resulted in 0.5 of a child per woman less in 2010 and 13 million fewer live births in between 1995 and 2010 (Kebede et al., 2019).

Comprehensive, integrated approaches, which take into account women's empowerment, education, family planning and legal reforms, are ways to encourage decline in childbearing. The benefits of population policies initiated in the 1960s in Kenya were only realized when female education expansion helped increase female literacy rates and made more accessible a reproductive norms media campaign, which advocated for smaller families (May and Rotenberg, 2020).

laws as instruments, higher levels of education attainment in 16 European countries was found to influence climate beliefs (e.g. concern about dependence on fossil fuel), behaviours (e.g. reduced energy use, energy-efficient home appliances), policy preferences (e.g. taxes on fossil fuels, renewable energy subsidies, a ban on inefficient household appliances) and voting for green parties. An additional year of education in Europe led to an increase of 4 percentage points in forming

favourable climate beliefs and a 35% increase in voting gains for green parties (Angrist et al., 2023).

Elsewhere, studies have found that education leads to environmental action more broadly. In China, increased educational attainment improved environmental knowledge, attitudes favourable to environmental protection (e.g. willingness to pay higher prices and higher taxes or to lower their standard of living) and corresponding behaviours (e.g. separating

TABLE 1:

Percentage of adults who agree with statements related to climate change knowledge, concern, government and individual action, 2022

Respondent education	Lower secondary	Upper secondary	Post-secondary
<i>Knowledge</i>			
I know a lot about climate change.	10	14	21
Climate change is happening.	81	90	92
Human activity is the primary cause of climate change.	38	44	49
I hear about climate change at least once a month in my daily life.	36	44	50
<i>Urgency</i>			
I am very worried.	42	40	43
It is a very important issue for me personally.	58	60	64
<i>Government action</i>			
It is a very serious threat to where I live.	44	45	49
It should be given high priority where I live.	63	69	73
We should reduce pollution, regardless of what other countries do.	31	42	52
Taking action will reduce growth and cost jobs.	33	31	28
Country should use more renewables.	48	53	60
Country should use more fossil fuels.	22	18	15
<i>Individual action</i>			
I am participating in a group working to convince leaders to take action.	12	9	9
I would definitely join a group.	23	25	28

Note: Facebook responses were collected in April–May 2022 from nearly 109,000 active adult users from 192 countries and territories, grouped into 107 individual countries and territories and 3 geographic groups.

Source: GEM Report team calculations based on Leiserowitz et al. (2022) and a communication with the Yale Program on Climate Change Communication.

waste for recycling, reducing car usage, reducing water and energy consumption, and buying locally produced and environmentally friendly products) (Q. Wang et al., 2022). An additional year of schooling in the Philippines increased the probability of sustainability-supporting actions, such as planting trees, recycling and proper waste management, by 3% (Hoffmann and Muttarak, 2020).

Scientific knowledge is also believed to lead to favourable attitudes towards the environment (OECD, 2022), although this is often not confirmed in practice. For example, while more than 90% of students in Costa Rica and Slovakia attended a school whose principal reported that climate change and global warming were covered in the curriculum, 90% of Costa Rican students but only 65% of Slovak students reported that protecting the environment was ‘personally important’ to them (Figure 4).

Better knowledge can improve some consumer behaviours but not all of them. Those in the top two levels of science proficiency (5 and 6), as measured by the 2018 PISA, were 1.4 times more likely than peers in the bottom two levels (1 and 2) to report they would reduce home energy consumption to protect the environment. However, top performers were less likely to sign petitions and boycott products or companies for environmental and other reasons compared to low-performing students, even among those with more favourable attitudes towards the environment. The misalignment between attitudes, knowledge and actions suggests that scientific knowledge and skills may not on their own activate environmental agency among students (OECD, 2022).

Individuals can experience a range of emotions related to climate change, from hope to anxiety and from grief to denial (Pihkala, 2022). Increased knowledge can also lead to further anxiety about climate change, when not accompanied by addressing these feelings and offering opportunities for engaging with climate action (Hargis and McKenzie, 2020). A study in the US state of North Carolina showed that climate change hope and concern were positively related to behaviour, while feeling despair was negatively related to behaviour (Stevenson and Peterson, 2016). Learning strategies that emphasize psychological and social dimensions can contribute to stronger beliefs in the potential of action for climate change (Ojala, 2017; Stevenson and Peterson, 2016; Verlie, 2019). In Sweden, unlike a sense of hope based on ignoring or denying the problem, a constructive approach to hope for climate change had a positive influence on environmental behaviour (Ojala, 2012).

Some aspects of climate change and its consequences may feel far away – due to psychological distance – and thus be difficult to prioritize in daily decision making (van der Linden et al., 2015). Data from the 2022 Yale Program on Climate Change Communication show that while most adults at all education levels perceive that climate change will cause future harm, fewer adults agree that climate change will cause a great deal of personal harm. The median gap is about 20 percentage points (Figure 5). On average, only 33% of those lower secondary educated, 34% of upper secondary educated and 36% of post-secondary educated adults agreed that climate change will cause them personal harm, compared to 51% of lower secondary educated, 59% of upper secondary educated and 66% of post-secondary educated adults who agreed that climate change will cause future harm. The gap between perceptions of

personal and future harm is higher for those with post-secondary (29 percentage points) than those with lower secondary education (18 percentage points). Adults in wealthier countries (e.g. Denmark) are more likely than adults in poorer countries (e.g. Malawi) to agree that climate change will have severe effects on future generations rather than on them personally.

Political polarization is another aspect that affects the relationship between education and beliefs on climate change. In the United States, more educated white males are less worried about global warming, less likely to perceive it as a personal risk and less likely to support regulation on greenhouse gas emissions. Instead of forming views that help protect the environment, educational attainment motivates white males to strengthen their opposition to climate policy and defend an individualistic position (Ballew et al., 2020). A meta-analysis covering 171 studies in 56 countries found that values, ideologies, world views and political orientation were more important in predicting belief in climate change than education, gender, experience or knowledge (Hornsey et al., 2016). Three international surveys covering 64 countries and more than 100,000 participants found that the effects of education on climate change awareness, beliefs about the human causes of climate change and perceptions of the seriousness of the issue were positive for the full population but weaker for those positioning themselves on the political right. For those on the political right, negative effects on climate change beliefs and awareness were also observed in Australia, Canada, Jordan, Morocco, South Africa and Ukraine (Czarnek et al., 2021).

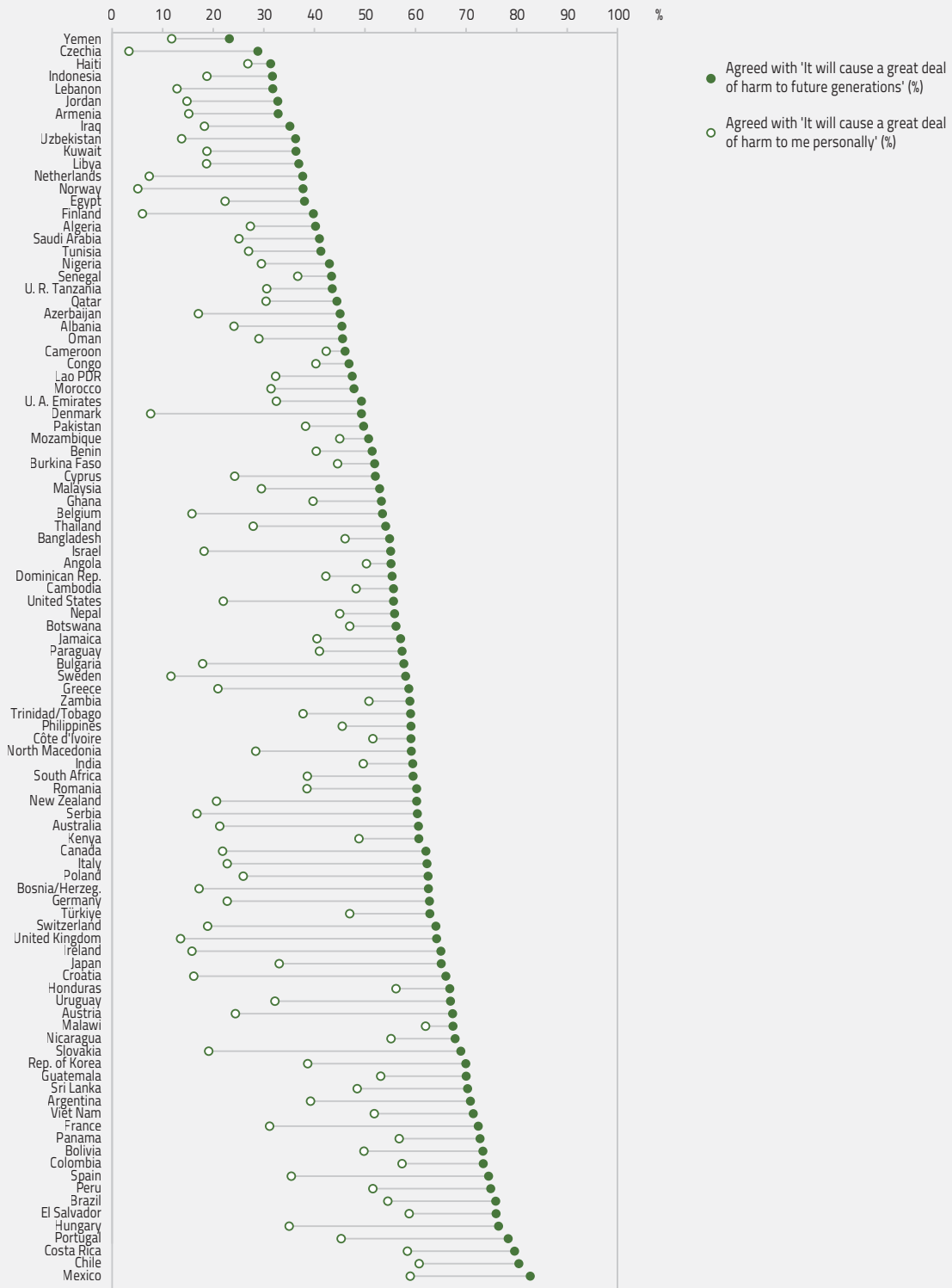
Thus, understanding how education motivates action requires taking into account not only the cognitive but also the social, emotional and behavioural dimensions of learning (Roemhild and Gaudelli, 2021) (Box 4).

ACTION-ORIENTED PEDAGOGY IS NEEDED

Concerns about the effectiveness of education, as currently delivered, spur debates on the curriculum, in terms of both how climate change is integrated across subjects and levels and on what types of learning it focuses. It is necessary to integrate climate change education across all subjects in holistic and actionable ways (Hargis and McKenzie, 2020; Lehtonen et al., 2018; MECCE and NAAEE, 2022; UNESCO, 2021b). Analysis of national curriculum frameworks provides one indication of whether such shifts are taking place. Across over 150 countries, there is substantial diversity in the

FIGURE 5:

People tend to believe that climate change will cause a greater deal of harm to future generations than to themselves
Adults who agreed that climate change will cause a great deal of personal harm or harm to future generations, 2022



Source: GEM Report team calculations based on Leiserowitz et al. (2022).

BOX 4:**Education or knowledge is only one aspect of motivating behaviour change**

In 2022, the Intergovernmental Panel for Climate Change concluded that behavioural interventions could increase the efficacy of subsidies and taxes. In their recommendations on decarbonization, the Science Academies of G7 countries urged governments to strengthen climate literacy and citizen involvement and to promote behaviour-oriented science to support transformative social innovations and increase support for technologies, policies and routines for carbon-neutral lifestyles (Jenny and Betsch, 2022).

A review of 10 meta-analyses on climate change mitigation field-based interventions found that the 6 intervention categories (education, feedback, commitment, appeals, financial incentives and social comparison) were generally effective in motivating climate action. Interventions based on social comparisons and financial incentives were the most effective, while those based on education and feedback were the least effective (Bergquist et al., 2023). While education is needed to make the public aware of a problem, it may not be effective at changing behaviours without additional interventions that include social-emotional and action components.

Climate change communication and education is most effective in motivating action when framed in the language, values and priorities of communities (Callison, 2020). Message framing strategies are needed to prompt action among those who believe in climate change and those who do not, especially if they are strongly swayed by political ideology (Badullovich et al., 2020). Climate messages that appeal to free market beliefs, security or patriotism; emphasize the near universalization of the climate scientist consensus; and use tools to enable adults to tackle misinformation are better suited to win over those resistant to action. Messaging based on hope to maintain urgency and emphasizing social norms of environment-protecting behaviour are strategies that can motivate action among climate change believers (Hornsey and Fielding, 2020).

Advancing from perceiving risks to adapting behaviour requires first-hand experience, resources to undertake protective actions, the perception of efficacy of those actions and feelings of personal responsibility. A survey of Australian residents found that messages with negative emotive content were particularly effective in prompting action when paired with concrete advice about how to behave. Individuals who perceive themselves to be personally responsible for avoiding or reducing adverse impacts are more likely to engage in behavioural adaptation, compared to individuals who believe that other people or agencies bear more responsibility (Wilson et al., 2020).

Systemic issues can also affect individual engagement with climate action. For instance, one plastic waste management strategy is plastic waste export from OECD countries to East Asian and Pacific nations. This artificial reduction in local plastic waste levels may influence consumers in wealthier countries not to prioritize plastic pollution reduction in their countries (Barnes, 2019). Another example is that the substantial price markups on products marketed as ecological deter consumers from buying them (Kearney, 2020).

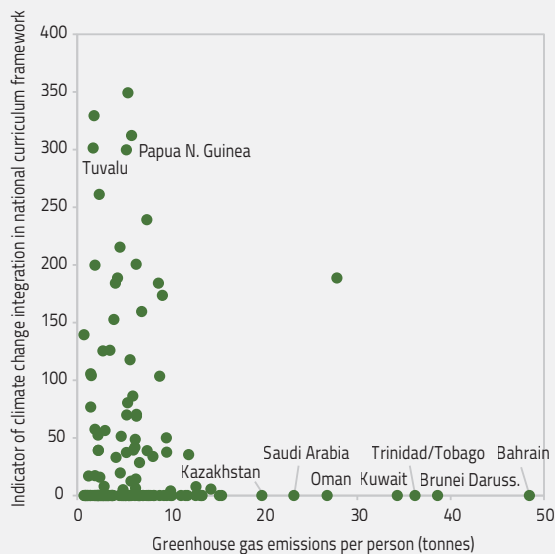
integration of climate change into national curriculum frameworks. More vulnerable countries, such as Papua New Guinea and Tuvalu, include climate change in their curriculum more than countries with high emissions per capita, such as Kuwait and Saudi Arabia (Figure 6).

More work is needed to ensure that all subjects include a focus on climate change. When looking at individual subjects, social science curricula include environment, sustainability and climate change content, but less so than science curricula. A study of grade 9 science and social science curricula from 85 countries found that environment, sustainability and climate change content is included at least one time in 82% of science and 73% of social science syllabi. A greater focus on

these topics is also more common in science than in social science subjects. However, the topics are rarely addressed in terms of community partnership or other aspects of school life, such as school facilities, operations or governance (UNESCO, 2024). Survey responses from 1,600 teachers and education leaders indicate that the subjects most likely to include environment-related content were biology, science and geography but the perceived level of inclusion was low (UNESCO, 2021b). An analysis of the Norwegian environmental and sustainability education curriculum from 1997 to 2020 found that education for sustainable development was given significant space in the natural sciences, but less so in social sciences, and even less in religion and ethics, and physical education

FIGURE 6:
Integration of climate change content in national curricula policy is higher among more vulnerable countries

Indicator of integration of Action for Climate Empowerment/Climate Change Education in national curriculum and per capita greenhouse gas emissions, 2022



Notes: The indicator on the vertical axis measures the extent to which environment, sustainability and climate change are included in national curriculum frameworks and education sector plans based on a search for 29 keywords.

Source: MECCE analysis of national curriculum frameworks; Jones et al. (2023) on greenhouse gas emissions.

(Tomren, 2022). Climate change education needs to embrace uncertainty, complexity and nuance; provide comprehensive empirical knowledge; engage in critical inquiry and cross-disciplinary perspectives; introduce transformative and learner-centred pedagogies and sustainability curricula; and ensure the meaningful participation of students in the study of climate change (Perkins et al., 2018).

Apart from curriculum integration across subjects, another criticism is that school curricula mostly focus on cognitive learning. A survey of 20 key informants from education or environment ministries highlighted that social-emotional and action-oriented learning are typically not emphasized, even though they are crucial for environmental and climate action (UNESCO, 2021b). An assessment of how climate change has been included in primary education in UNFCCC country

submissions found that 67% focused relatively more on cognitive learning, 7% on social-emotional learning and 27% on behavioural learning (UNESCO, 2019). In Austria and Germany, a study of 1,000 secondary school geography students found that they did not know about the interdependence of consumption and production networks in sustainability. While most students understood sustainability and sustainable behaviour, their understanding of a sustainable lifestyle was simplistic (Kowasch and Lippe, 2019).

The need for project-based or experiential and holistic learning has long been recognized as a prerequisite for action, notably under the concept of Education for Sustainable Development (UNESCO, 2020). Research also concurs with the need to include experiential and inquiry-based active collaborative learning (Kagawa and Selby, 2022). University educators from 45 countries highlighted that the most efficient way to integrate climate change into teaching is through problem-based learning, followed by experiential learning and fieldwork (Filho et al., 2021).

One review of 49 studies highlighted making climate change personally relevant for learners and encouraging engagement and student empowerment as key success factors for long-term impact (Monroe et al., 2019). Another review of 220 studies found that didactic approaches to teaching about climate change have largely been ineffective, as children's understanding of climate change issues remains erroneous and influenced by the media (Rousell and Cutter-Mackenzie-Knowles, 2020). An analysis of 178 peer-reviewed studies on climate literacy and education, from kindergarten to university, found that integrating students' culture, beliefs and location with disciplinary knowledge about climate change allows students to advance from retaining scientific facts towards experiencing the full range of issues related to climate change (Bhattacharya et al., 2021).

Holistic climate change education can also include outdoor and place-based education, especially for younger students, as developing environmental awareness and interest early in life is a critical foundation for developing attitudes and behaviours supportive of climate change action in adulthood. A systematic review of 66 studies, mostly from the Global North, on early childhood environmental education found that programmes involving 4- to 5-year-old children in nature-rich settings had positive outcomes for environmental, cognitive and affective dimensions (Ardoin and Bowers, 2020).

A longitudinal analysis of children in rural New York identified the time spent outdoors at age 6 as a predictive factor for more favourable behaviours towards the environment at age 18 (Evans et al., 2018). In Japan, early childhood education has long included traditional pedagogy and practices of nature-based activities such as gardening and care for animals. A survey found that over 90% of Japanese early childhood centres had garden beds or planters where children could independently grow flowers and vegetables. Teachers used books, posters, stories, displays of natural materials and informal discussions about nature to intentionally engage children in nature education (Inoue et al., 2017). A review of 15 school projects applying innovative ideas on agriculture, biodiversity, disaster risk reduction, forestry and water management in low-, middle- and high-income country contexts showed it is important for children to have first-hand experience of nature as a step for adaptation and climate resilience (Singh and Shah, 2022).

Countries have various ways of broadening their pedagogical approaches (**Box 5**). Such social-emotional learning aims to build self-awareness, social awareness, relationship skills and responsible decision making, as well as to help deal with climate change anxiety and grief. It helps students reflect on how climate change makes them feel, how it is impacting their communities, how to talk about climate change, and what can be done to help address it (Srinivasan, 2021).

Much of the evidence on the impact of climate action-oriented projects and the advantages of exploration, community-based work, and engaging with teachers and experts is generally small-scale. As part of the Generation F3 inquiry-based climate change education project, 16- to 18-year-old students in Austria and Italy who collaborated with experts on local climate change adaptation improved their adaptation knowledge levels and developed critical and forward-thinking skills more than peers who experienced the standard curriculum (Schrot et al., 2021). A Swedish municipality designed a teacher professional development course focused on action competence for sustainability. Upper secondary school students who benefited from this cross-disciplinary, action-oriented and pluralistic teaching approach became more knowledgeable of possibilities for action and were more willing to act (Olsson et al., 2022).

In China, an analysis of secondary school students in Shanghai showed that those who engaged in activity-based learning tended to have more climate-conscious behaviour than those who learned through other sources, such as the media (Wu and Otsuka, 2021). In Malaysia, students who followed five weeks of instruction based on engagement, exploration, explanation, elaboration and evaluation performed significantly higher on global warming knowledge and environmental attitudes relative to students who were taught in traditional, teacher-centred ways (Karpudewan et al., 2015).

A quasi-experimental study of community-based environmental education in 12 Nigerian primary schools found that experiential learning approaches helped students understand and address local environmental problems. Students in the programme did significantly better than those in the control group receiving traditional instruction in terms of environmental knowledge as well as skills to solve immediate and future environmental problems (Ajitoni and Gbadamosi, 2015). As part of the Keep it Cool project in South Africa, 300 secondary school teachers were trained to collaborate and become members of professional learning communities. They improved their teaching practices and enhanced their ability to incorporate indigenous knowledge (Heimann et al., 2022). In the absence of large-scale research, the evidence base is often complemented by accounts of exemplary institutions or school networks that engage with climate action and resilience (**Box 6**).

University courses have also involved students in experiential learning and community engagement. An intensive one-year course in San José State University in the United States led to actions that reduced the average student's annual carbon emissions by 2.86 tonnes of CO₂. The positive effects were attributed, at least partially, to two experiential learning tools: activities in which students explored connections between climate change and their personal and professional lives; and a community action project in which student teams designed and implemented plans to reduce carbon emissions in a community of their choice. Focus group participants cited the key role of community action projects in developing their understanding. Scenario-based estimates showed that if such programmes were applied at scale in secondary schools, they would reduce carbon emissions at a scale similar to mitigation strategies such as adopting rooftop solar panels or electric vehicles (Cordero et al., 2020).

BOX 5:**Some countries envisage a broad-based pedagogical transformation approach**

Faced with the limitations of an exclusive focus on cognitive learning, some countries have been implementing transformative approaches. In Cambodia, an expanded earth science curriculum was introduced in upper secondary schools in 2020. The environment and education ministries have collaborated in 15 pilot schools, where students received additional teaching on climate change and worked with teachers on resilience projects, such as tree planting and climate-smart agriculture (Ellerbeck, 2022; Sargren et al., 2019).

In Finland, the revision of the national curriculum in 2016 mandated a learning approach furthering interdisciplinary approaches to climate change, food production and water quality. Working in teams and guided by teachers, students acquire knowledge and skills through field observations, stakeholder interviews and responsible actions (Lähdemäki, 2019). Some analysis of Finnish policies highlights that other education policy objectives and implementation gaps thwart educational efforts to deal effectively with large-scale challenges such as climate change. Further research is necessary on how policies can support world-view transformation in ways that support student agency (Zilliacus and Wolff, 2021). In France, the Ministry of National Education and Youth provides a wide range of resources for educators and the public through Réseau Canopé, including on eco-anxiety related to climate change. In Iceland, Astrid, a digital platform, provides holistic climate change education. It aims to reach students early to inspire action and combat climate anxiety with scientific evidence.

Mexico views environmental education as promoting knowledge, values, attitudes and skills to allow students to participate in the analysis, prevention and reduction of environmental problems. In Rwanda, the Ministry of Education rolled out a new competence-based curriculum framework for sustainable development as a cross-cutting issue integrated across multiple subjects and through hands-on projects in partnership with community-based programmes (ARCOS Network, 2022; Muhirwa, 2023). In Singapore, the Eco Stewardship Programme aims to strengthen the curriculum by expanding climate education in schools, incorporating it into the character and citizenship education syllabus, and providing more funding for experiential learning and co-curricular activities (Singapore Ministry of Education, 2021). In Tuvalu, a climate change education resource is used to guide teachers through lesson plans, which reference cognitive, action/behavioural and social-emotional learning dimensions. In Türkiye, the 2022 Climate Change Action Plan envisages restructuring the psychological counselling services framework to align with environmental and climate change objectives and sustainable development.

Disaster risk reduction is a key focus of curriculum change in vulnerable countries. In Indonesia, the national curriculum revision process began in 2021 under the Merdeka Belajar (Freedom to Learn) policy, which promotes a pedagogical shift from teacher-directed instruction and rote memorization to approaches that focus on developing students' critical and creative thinking skills. Disaster risk reduction themes and topics are incorporated into social studies, science and physical education at grade-appropriate levels, with space to adapt the content and methods to the local context (Teixeira and Crawford, 2022). In Saint Vincent and the Grenadines, the climate change mitigation and adaptation and disaster risk reduction curriculum, developed by the Ministry of Education in 2019–20, employs a range of interactive, participatory and experiential learning modalities (Selby et al., 2020).

The need to begin encouraging children to learn about sustainability issues in early childhood education is receiving policy attention. In New Zealand, the bilingual and bicultural early childhood curriculum, Te Whāriki, was introduced in 1996. It highlights the critical role of understanding Māori cultural heritage, which emphasizes the interdependence of the social and natural worlds (Lee et al., 2013). In Viet Nam, the Ministry of Education and Training has developed a national climate-smart preschool framework and guidelines and training materials for preschool teachers (UNICEF EAPRO, 2022).

Art has a unique ability to engage learners in exploring environmental issues. It encourages critical thinking and creativity, allowing for space to visualize the impacts of climate change or explore innovative ways to mitigate them through artistic expressions. Such education need not remain within formal settings. Community engagement and collaboration can also be fostered through public art projects, building a sense of responsibility by sparking conversations and raising awareness, inspiring others to adopt climate responsible behaviours. In Brazil, Colégio Santa Chiara in Sergipe state launched the Globinho Activists programme to teach students about the rivers and waterways in their region through art illustrations (UNESCO, 2023).

BOX 6:

School networks have experimented with action-oriented learning

School networks have been a testing ground for action-oriented pedagogies, although evidence on their impact is lacking. The UNESCO Associated Schools Project Network consists of over 10,000 schools in 181 countries. Schools promote a whole-school approach to transforming learning and integrating local and global sustainability issues into the curriculum. Guidelines for school governance, teaching and learning, critical thinking, student empowerment, and facilities for climate action were developed after a review of projects in 55 schools in 12 countries (UNESCO, 2016b). A review of the implementation of these guidelines in 27 Canadian school members of the UNESCO Associated Schools Network found that the network structure was a key driver for climate change education (Chopin et al., 2018; Hargis et al., 2021).

Eco-Schools, a programme organized by the Foundation for Environmental Education, requires students in over 59,000 schools in 68 countries to form an eco-committee, conduct an environmental review, develop an action plan, analyse implementation, develop monitoring and evaluation plans, link and embed climate change into the curriculum, inform and involve all stakeholders, and rely on a code of values for the school, which helps cultivate a mindset that values sustainability and builds cognitive and interpersonal competencies, attitudes and values (Foundation for Environmental Education, 2019). Eco-schools and similar programmes advance a whole-school approach to climate and environmental action, for instance through reducing schools' footprint and embedding sustainability in school governance (Foundation for Environmental Education, 2017; UNESCO, 2016).

The Climate Action Schools project was launched in 2022 with 100 founding schools from 26 countries, which have collected and visualized data on carbon emissions using a tracking application, carried out school-to-school virtual exchanges, and planted trees. The project aims to help teachers align their instructional practices with content standards while offering engaging learning opportunities based on collective action (Take Action Global, 2023).

Sesame Workshop India launched the Environment Stewardship programme, Mera Planet Mera Ghar (My Planet, My Home), in 2020. It created an environmental literacy curriculum for 5- to 10-year-old children based on science, technology, engineering and mathematics. Students have been engaged on issues of air quality and waste management. The programme has also partnered with the Municipal Corporation of Delhi to amplify environmental messages (Clean Air Fund, 2023; India Climate Collaborative et al., 2022).

Science Education for Action and Engagement towards Sustainability (2019–22) connected 39 primary and secondary schools and 186 non-school organizations in Austria, Belgium, Estonia, Italy, Norway and Sweden. The pedagogical approach views schools as flexible structures open to society and able to make a difference. The project focused on sustainability challenges, such as plastic pollution, and the need to address them through interdisciplinary knowledge, creative collaboration and active citizenship. Inquiry-based, action-oriented teaching to empower learners required the time and space to enable collaboration between schools and non-school partners (Jornet et al., 2022; Mueller et al., 2022).

At the University of Sao Paulo in Brazil, most educational initiatives on climate change are carried out through an interdisciplinary climate investigation centre, which promotes collaboration, networking and knowledge exchange between various research areas. A strategic pedagogical approach at the Federal University of Para links teaching and research with local actions to promote Amazon conservation through the emancipation of indigenous and peasant communities and a balanced approach to achieving development and sustainability objectives (Brandli et al., 2022). But universities also have a role to play in preparing teachers, many of whom feel unprepared to teach climate change, especially using action-oriented pedagogy (Box 7).

FORMAL EDUCATION DEVELOPS SKILLS FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

Formal education tends to be thought of only for the role it plays in relation to general knowledge about climate change mitigation and adaptation. However, it is also critical for specialized knowledge and technical capabilities to mitigate and adapt to climate change. In a survey of some 12,500 businesses in the European Union, more than 80% believed that the skills shortage was preventing climate change projects from advancing (European Investment Bank, 2023). In the United Kingdom, a survey of engineering employers on requirements for delivering the government's net

BOX 7:**Teachers feel underprepared to teach climate change education**

Teachers recognize the importance of climate change but often report they feel ill prepared to teach it. Most teachers surveyed in the United Kingdom supported an action-based climate change education curriculum, which included issues of global social justice, beginning in primary school with mitigation projects (Howard-Jones et al., 2021). While a majority of more than 58,000 teachers from 144 countries and territories believed that it is important to teach about climate change, less than 40% were confident enough to teach it and only about one third felt they would be able to explain well the effects of climate change on their locality (UNESCO, 2021c).

Teachers often lack training and support for covering new curricula and engaging with interdisciplinarity in relation to climate change education. About two thirds of 80 countries reviewed had frameworks to support climate change education in teacher training education (UNESCO and MECCE, 2023). In the Dominican Republic, a national strategy for climate change learning was first launched in 2012 to support low-emission and climate-resilient development. The National Teacher Training Institute developed a course in partnership with UNESCO and UN Institute for Training and Research called CC:Learn. By 2017, more than 3,200 teachers had completed the training. In 2016, more than 300 professors from 8 universities were trained to create a tertiary education climate change programme (UN CC:Learn, 2017).

Effective teacher training for climate change education should include adequate preparation in understanding and validating emotions to help students engage constructively and with hope in climate change practices (Ojala, 2023). A survey of teachers' perceptions of students' emotions about climate change in Australia found that teachers require resources to support environmental learning that fosters students' emotional well-being, acknowledges their feelings and promotes hopefulness (Baker et al., 2021). Promising practices include helping students engage with the community, solving issues, inviting outsiders to share stories of their persistence despite challenges, and having students reflect on problems as well as on progress related to climate change (Ojala, 2016).

Teachers have reported that collaboration, professional development and communication are key to overcoming lack of training about climate change education. A survey on climate action of over 1,000 teachers and staff from 38 countries found that they considered communication and collaboration within and between schools important. Nearly half cited a lack of available or suitable resources as a major challenge. Effective tools to overcome a lack of knowledge about climate change were professional development, help from experienced colleagues and inviting experts into the classroom as guest speakers. Teachers found cross-curriculum projects with real-life impact the most motivating for students to engage in climate action (Shift Sustainability et al., 2023). Primary and secondary school teachers from India and Romania highlighted that their most commonly used climate action interventions were guest lecturers, research projects, sustainability practices, social media campaigns and cultural exchanges. Lack of time, financial and other resources, and inadequate teacher training were the main barriers to delivering education focused on climate action (Shift Sustainability et al., 2023).

zero target by 2050 showed that while 55% were in businesses that had a sustainability strategy, less than 10% believed they had all the skills their strategy needed (IET, 2021).

Some of the key sectors that require workforce transitions include energy, agriculture, forestry and planning. The renewable energy sector grew from 7.3 million workers in 2012 to 12.7 million in 2022. National (Rutovitz et al., 2021) and international (IRENA, 2023) assessments highlight skills shortages for the energy transition and the need to integrate renewable energy into curricula, expand technical and vocational

education and training opportunities, develop retraining and certification pathways, and better coordinate training providers and industry. Leading countries on the renewable energy transition emphasize training skilled workers to ensure that job creation and the green transition go hand in hand. Chile, Denmark, Jordan, Lithuania, Namibia, the Kingdom of the Netherlands, the State of Palestine and Uruguay have developed solar and wind energy faster than is needed to stay on track for net zero (Jaeger, 2023). In Denmark, 40% of energy comes from wind, bolstered by 75,000 new jobs (Denmark Ministry of Foreign Affairs, 2020). In Uruguay, wind power expansion was driven by various

factors, including a partnership for skills development between the Ministry of Labour and Social Security and the International Labour Organization, funded by the Swedish International Development Cooperation Agency (World Resources Institute, 2021).

Training and capacity building efforts focused on climate change adaptation and mitigation are required to ensure sustainable forest management. In the Dominican Republic, the Center for Agricultural and Forestry Development promotes sustainable development in the agricultural and forest sectors through training, information, institutional innovation, and sector policies and strategies. The Campaign for Female Education (CAMFED), a non-governmental organization, has been equipping thousands of female agriculture guides with skills to support their communities' adaptive capacity and climate resilience. Their role is to build the skills of smallholder farmers and parent support groups. In Zambia, the project allocated 304 hectares of agricultural land to young women leaders to establish large-scale climate-smart demonstration farms. In the first phase, 40 CAMFED guides helped transfer knowledge and skills to 8,500 women (Kwauk et al., 2022).

The Swedish Forest Agency conducted a large communication project called *Forestry in a Changing Climate*, which educated private forest owners and forestry professionals about the risk of climate change. The training was carried out by local employees of the forest agency and reached 17,200 forest owners. A survey of 3,000 forest owners showed that the training had measurable effects on their perceptions of the ability and intention to adapt. About 37% of forest owners who were reached felt they had enough knowledge to implement adaptation measures in their forests, compared to 23% of forest owners who had not taken part in the training (Bharwani et al., 2016).

Similarly, with respect to sustainable management of oceans, education provides tools for ecosystems managers and material for capacity building in ecosystems management, and is required for a well-trained national workforce (Le Blanc et al., 2017). Analysis of professions related to ocean sciences highlights that there are requirements for more support for education and training in new domains such as ocean data and information management, for which there is currently no formal education (IOC-UNESCO, 2020).

Many countries also recognize the need to develop government officials' capacity for climate change adaptation and mitigation. The Bangladesh Public Administration Training Centre has initiated several training programmes on climate change-related topics. Canada's 2030 Emissions Reduction Plan mandates that some 7,000 federal executives must take a course on climate change and net zero, grounded in the best available science and indigenous knowledge. In China, the Ministry of Education developed training materials to build capacity on climate change content, governance and finance. In India, according to the National Training Policy, 2.5% of salaries are to be used for training in climate change, sustainable development and capacity-building initiatives, with additional international funding support. Several countries also highlight the need for local government capacity development. Costa Rica's 2018 National Adaptation Plan highlights the need to train regional, municipal and local government officials and communities prone to experiencing climate emergencies. The Korea Adaptation Center for Climate Change offers educational materials for local governments on climate change impact and on the development of successful climate change response strategies. In New Zealand, the government helps local governments organize training in response to and in preparation for climate change to increase readiness.

Greening technical and vocational education and training (TVET) systems requires developing competency standards, designing curriculum, providing training, offering teacher professional development, engaging with employers, and focusing on workplace learning (ILO, 2022). A compilation of 80 climate change and communication profiles found that 68% of TVET policies included climate change in law, policies or plans (UNESCO & MECCE, 2023). However, an assessment in 32 countries found that comprehensive and coordinated skills policy development coupled with strong environmental performance were only present in a handful of high income countries (ILO, 2019).

Greening TVET requires making it more relevant. In Brazil, those responsible for waste picking around the country are being upskilled through government initiatives (Capozza and Samson, 2019). In Costa Rica, the National Institute of Apprenticeship provides technical training by maintaining direct contact with companies to identify training needs for occupations in all productive sectors in the shift to a greener economy. In Estonia, the skills anticipation system, OSKA, highlights the shortages in the construction

industry, engineering and other sectors; which are then addressed through a partnership across TVET schools and employer groups. Construction practitioners are involved in teaching or in supervising school practical training (ILO, 2022). In India, an evaluation of the Suryamitra training program that trained over 78,000 solar technicians between 2015 and 2021 found that most trainees and trainers reported an improvement in their technical knowledge and expressed confidence in improved job opportunities (Tyagi et al., 2022).

University education also needs to be reshaped to address climate change, not only in the sciences but also in social sciences, arts and the humanities (Molthan-Hill et al., 2019, 2022). For instance, urban planning curricula have typically not taken into account climate change challenges despite the discipline's unique role in shaping the built environment. Analysis of urban planning degrees in Australia and the United Kingdom found that explicit coverage of climate change issues and sustainable urbanism was low (Hurlimann et al., 2021; Preston-Jones, 2020). Content analysis of 53 urban planning curricula in 29 universities in 9 sub-Saharan African and 3 South-eastern Asian countries found limited engagement with the consequences of climate change. Of over 1,000 courses taught at these universities, climate change and disaster risk reduction were taught in only 5% of planning courses in sub-Saharan Africa and 12% in Southeast Asia (Scholz et al., 2021). Another analysis of the use of climate change adaptation pedagogy in three universities in Namibia, South Africa and Zimbabwe found that, while climate change is recognized as a planning dilemma, it is yet to be integrated into the curriculum (Matamanda et al., 2022).

Universities typically focus on reducing their institutional carbon footprint, starting with greening campus operations and making the built environment sustainable. Examples include waste management, improving materials and resource use, retrofitting residential and non-residential buildings, increasing green areas, and promoting the use of green transportation. The United Nations Environment Programme has been working with higher education institutions to develop and implement national and regional green university networks in Kenya, Morocco, Uganda, western Africa and western Asia. In 2019, 18 Kenyan universities established the Green University Network. However, universities are often not doing enough, despite intentions of leadership on climate

change. A systematic review of carbon footprint analyses that evaluated studies on 34 universities around the world found a lack of a clear methodology to verify how higher education institutions are offsetting greenhouse gas emissions (Valls-Val and Bovea, 2021). A study of how 230 higher education institutions in the United States were engaging with climate change in their policies found that climate change was more common in overall governance, facilities and operations policies and less common in teaching and learning, community partnerships, and research policies (MECCE Project and NAAEE, 2023).

Universities also focus on curricula and pedagogy to educate students on climate change mitigation and adaptation, referred to as the 'carbon brainprint' (Filho et al., 2021). For example, universities strengthen the capacity of primary and secondary education systems; translate the science of climate knowledge into programmes that can be tailored to students, teachers and schools; educate the public and professionals; and engage university students in problem-based learning (Reimers, 2021). The Times Higher Education Impact Rankings' assessment of 735 institutions from 93 countries in 2023 showed that the best performing universities on sustainability are those that had a high number of published climate action papers, engage with industry and government, and offer courses focused on sustainability (Times Higher Education, 2023).

Universities are accelerating their work on climate change research and policy leadership. Globally, across disciplines, research publications on climate nearly tripled between 2010 and 2020 (MECCE, 2024). Columbia University founded the Columbia Climate School for interdisciplinary research in 2020, integrating its various institutes and centres (Halliday, 2020). The Massachusetts Institute of Technology's Climate Action Plan and its energy initiative includes a range of energy education resources for students, certification for online learners and network building with other universities. The Climate Action through Education programme, to be launched in 2023, aims to develop interdisciplinary, solutions-focused climate change curricula for secondary schools in history/ social science, English/language arts, mathematics, science and computer science (MIT, 2021; MIT Energy Initiative, 2023). The Carbon Literacy Training for Educators, Communities, Organizations and Students is a virtual programme developed by the Nottingham Business School in collaboration with the United Nations Principles for Responsible Management Education

initiative. It focuses on carbon literacy training for business schools and for primary and secondary school teacher education, support to small and medium enterprises, and adaptation for key industries and sectors (Nottingham Trent University, 2023).

ActToday, a project of the International Research Institute for Climate and Society at Columbia University for ‘adapting agriculture to climate today, for tomorrow’, has invested in the development of Climate National Academies in Bangladesh, Colombia, Ethiopia and Guatemala. In Ethiopia, the Climate Services Education Initiative embedded curricula and training activities on climate risk management. Capacity-building efforts targeted farmers, agricultural extension agents and other professionals. University-trained graduates on climate risk management were prepared with diverse skills to work in government agencies dealing with food security and disaster warning activities (Braun et al., 2023).

STUDENTS AND YOUTH ARE ADVOCATING FOR A BROAD VISION OF CLIMATE CHANGE EDUCATION

Despite progress in education systems’ response to the climate change challenge, many students and youth find formal education lacking, and call for more action-oriented and psychosocial learning and a stronger focus on justice issues. A survey of over 2,000 young respondents from 53 countries found that 95% were worried about the effects of climate change and environmental degradation, while 36% highlighted the importance of inclusive and accessible education of good quality as a priority for addressing climate change; but only one quarter of young women and just over one third of young men felt that their education had prepared them to address climate change (Plan International, 2022).

According to a survey of 16- to 25-year-olds in Canada, 60% believed that the formal education system should focus more on the social-emotional dimensions of climate change. Respondents indicated that they would also prefer more climate change content in classes, mental health support, reassurance, positive and hopeful messaging, and teaching about the urgency of climate risks (Galway and Field, 2023).

Systematic reviews have concluded that the political dimensions of climate change are often missing in formal education. Climate change is primarily taught in science subjects. An analysis of 55 articles written between 2017 and 2020 highlighted that justice-driven

climate change education was difficult to implement in formal education due to current structures, curriculum standardization and accountability mechanisms. Climate justice was often taught in non-formal settings, with student and teacher activists learning about justice dimensions from each other and acting as educators for their communities (Trott et al., 2023).

Although young activists and advocates in the Global North and the Global South had been undertaking actions for climate justice for years without recognition and media coverage, the Fridays for Future movement, spearheaded by Greta Thunberg in 2018, is often credited with expanding local and national youth engagement and awareness efforts of climate change to a global scale (Venghaus et al., 2022). Discussions with school strikers for climate action show that students are learning from their participation in the strikes, complementing their often insufficient climate change education in schools. In turn, they are also becoming climate change educators (Verlie and Flynn, 2022). Students are teaching themselves the knowledge that they need to engage with climate change issues outside of classrooms, such as dealing with regulations, negotiating with police, organizing a web presence and developing policy demands by improving their competencies in political engagement (Bowman and Germaine, 2022). They also teach their teachers how to reducing the school footprint (Hargis et al., 2021).

Youth activists have supported climate science as new ambassadors and communicators for scientific consensus and climate adaptation and mitigation (Eide and Kunelius, 2021). An analysis of 50 youth-led climate initiatives, of which 30 were initiated by youth, found that most were aiming to exert political pressure. The skills focus in these initiatives were advocacy and communications, literacy and leadership related to climate change (Chemonics International and Unbounded Associates, 2022).

Students have also highlighted inadequacies in school textbooks. In Berlin, students analysed actions discussed in geography, chemistry and biology textbooks aimed at 11- to 18-year-olds in Australia, France, Germany, the United Kingdom and the United States. High-impact solutions (e.g. living car-free) received little or no mention while low-impact solutions (e.g. recycling) were discussed more extensively. Some of the proposed solutions had not been updated for 25 years, making textbook reform urgent (Collins and Osborne, 2019).

A lack of national and global efforts on climate change has been portrayed as a human rights violation. By the end of 2022, 2,180 climate change cases had been filed, of which 1,522 were in the United States (UNEP, 2023). Litigation by youth has been a sign of increasing political involvement in climate action, although cases tend to be dismissed early. Analysis of 23 cases in 14 countries shows that where a first decision was rendered, only 3 cases were heard on their legal merits: in Colombia (on the government's failure to reduce deforestation in the Amazon), Germany and Norway (Parker et al., 2022). In the US state of Montana, a court ruled in favour of young plaintiffs who alleged that the state violated their right to a clean and healthy environment by allowing fossil fuel development without considering its climate consequences (Montana First Judicial District Court, 2023). Youth litigation also has a transnational dimension, where young people from the Global South call out climate injustice for which the Global North is largely responsible. However, these international cases have been dismissed in most contexts (Gradoni and Mantovani, 2023).

At the higher education level, climate activism also focuses on university policies and approaches. Fossil fuel divestment movements at universities and colleges are often led by students. In the United States, students and others have pushed 141 higher education institutions to divest their endowments from industries producing fossil fuels since 2012 (Barron et al., 2023). Analysis of 220 Canadian universities and colleges found 38 active divestment campaigns, of which 31 were initiated by students, with 6 institutions then committing to varying degrees of divestment (Maina et al., 2020). There are also growing calls by scientists and researchers for universities to facilitate further academic advocacy and activism in climate and ecological emergencies, shifting the focus from primarily publications onto public actions, and providing space for academics to engage in such efforts (Gardner et al., 2021).

University students have advocated for climate inclusion within their curriculum, for instance in health and architecture education. Students from 2,817 medical schools in 112 countries reported that climate change is taught in less than 15% of medical schools worldwide. Students led climate action-related activities in another 12% of medical schools (Omran et al., 2020). Medical students founded the Planetary Health Report Card to inspire medical schools to engage with the subject. Since 2019, more than 60 medical schools in Canada, Ireland, Malaysia, the United Kingdom and the United

States participated in the report card, catalysing the inclusion of integrated curricula in many of these institutions (Hampshire et al., 2022). Climate change has also received attention in architectural education. Over 4,000 architects in 18 countries declared a biodiversity and climate emergency, with over 2,500 architecture students and teachers signing a declaration calling for curriculum change in architectural education. A review of 71 studies on the integration of sustainability education into architecture highlights the need to shift from educator-centred teaching to student-centred learning methods with collaborative, reflective and deep learning strategies (O'Dwyer et al., 2023).

INFORMAL EDUCATION THROUGH COMMUNICATION AND INCENTIVES IS A VITAL TOOL

Climate change education cannot stay limited to formal education. Public communication and awareness campaigns often offer more effective non-formal and informal learning opportunities. They aim to inform, raise awareness, shape public understanding, change behaviour, network and put pressure on decision makers (Segeberberg, 2017).

GENERAL COMMUNICATION CAMPAIGNS NEED TO BE SENSITIVE TO CONTEXT

An overview of 80 countries showed that nearly all countries include public awareness campaigns in laws, policies or plans (UNESCO and MECCE, 2023). These involve a range of actions and actors. In Indonesia, the 2019 climate campaign and climate festival included a car-free day, a cycling promotion programme and a forum on the ethical dimensions of climate change. In Mexico, the Centre for Education and Training for Sustainable Development promotes citizen environmental education in public places such as zoos, parks and museums. Around 400 such Environmental Education and Culture Centres have been certified, of which 9 work on climate change matters, facilitating access to scientific information.

The European Commission public communication campaign on climate change 'A world you like. With a climate you like', initiated in 2012, engaged more than 250 public authorities, non-governmental organizations, universities and businesses as official partners. More recently, the 'You are EU' campaign has focused on improving awareness of energy consumption to help make the shift towards the environmentally

friendly choices of clean and homegrown energy (von der Burchard, 2023; European Commission, 2023). In 2010–14, 'Redraw the line', a regional campaign launched initially in the Philippines, Thailand and Viet Nam, used both traditional and online media to increase consumer demand for socially responsible products and services and minimize consumers' impact on the environment. Public service announcements received extensive airplay on cable channels and YouTube videos, while university students were engaged during 'No impact' weeks and on social media (The Media Alliance, 2016).

Newspaper and television coverage provide an indication of the growth of public dissemination of information on climate change. An analysis of climate change representations by 37 newspapers in 27 countries found that coverage expanded from 1996 to 2010. Countries with obligations under the Kyoto Protocol had more extensive media coverage, while carbon-intensive societies had more extensive debates on climate change and politics (Schmidt et al., 2013). Relating to this analysis, a review of 18,224 articles published from 1997 to 2016 in 2 Indian newspapers also found that climate change coverage had increased substantially, notably after 2007, but remained at half the level of other countries (Keller et al., 2020).

Analysis of news media coverage in 2006–19 in Australia, Canada, Germany, India, Namibia, New Zealand, South Africa, Thailand, the United Kingdom and the United States found that while all countries had news reporting on the scientific and social consequences of climate change, there was more focus on climate science in the Global North and on human consequences in the Global South (Hase et al., 2021). Analysis of Japanese newspapers in 1998–2007 showed that a dramatic increase in newspaper coverage of global warming correlated with an increase in public concern for the issue (Sampei and Aoyagi-Utsui, 2009). But climate change messaging on television in the United States has helped discredit climate science (Feldman, 2016), as some media are used to lower people's trust in scientists and their certainty that global warming is happening (Hmielowski et al., 2014).

Social media platforms, including Facebook, Instagram and Twitter (now 'X'), have been used to share opinions on climate change instantly through vast cross-border networks (Mavrodieva et al., 2019). However, information sharing through social media also leads to opinion silos and reinforcement (Anderson, 2017).

Analyses of Twitter messages to assess user attitudes towards climate change found that groups are usually segregated into like-minded communities, where they express polarized opinions (Falkenberg et al., 2022; Williams et al., 2015).

Some strategies focus on making climate change communication more personal and experiential and leveraging relevant social group norms. A review of 19 studies found that when individuals perceive climate change as more proximate and concrete, they have a higher propensity to behave in ways that protect the environment (Maiella et al., 2020). Inviting Australians to watch a four-minute video that portrayed climate impacts as mostly happening in Australia, rather than in faraway places, lowered the psychological distance and in turn increased their concern levels and intention to behave in ways that help mitigate climate change (Jones et al., 2017).

The idea of making messages specific to their context characterizes several communication efforts at the national and local level (**Box 8**). In India, the National Bank for Agriculture and Rural Development in partnership with the Centre for Environment Education launched Jal Jivan Hai (Water for Life), a major education and communication campaign to create awareness among rural communities about water conservation and efficient water technologies. Over 8,000 youth were trained as campaign facilitators and implementers at the local level. They received a detailed manual on running the campaign and a kit with educational resource materials to conduct a 'day in a village' campaign, which reached over 100,000 villages in 21 states. Some countries incorporate local and indigenous knowledge to acknowledge history, vulnerabilities and lessons that can be learned from traditional knowledge systems (Orlove et al., 2022). Zambia's 2021 National Climate Change Learning Strategy aims to promote the involvement of local authorities and traditional leaders and the use of indigenous knowledge in public awareness campaigns.

The role of education-focused climate change non-governmental organizations in communications is important. An online platform that compiles information on environmental organizations and businesses currently lists over 1,100 as working on education issues globally (EcoHubMap, 2023). Another global database has mapped over 3,000 organizations involved in climate change education, of which 1,000 are based in Europe (MECCE, 2024). In India, the Centre for Environmental Education, established under the

Ministry of Environment, Forest and Climate Change, provides a variety of educational resources and carries out a range of programming, research and policy engagement activities (Sarabhai and Kumar, 2023).

The impact of public awareness campaigns is often not assessed beyond the number of people reached. An analysis of 78 studies found that climate change communication that increases public knowledge has contributed to public engagement on climate change policy (Khatibi et al., 2021). In Australia, the 'Think Change' Climate Change Household Action Campaign 2008–2009 was the last federal awareness campaign implemented through mass media; an evaluation by the Department of Climate Change examined elements of campaign design, budget, management, outputs

and short- to medium-term results. The evaluation noted that climate change was the second-most widely mentioned issue of importance to Australians, even though the media was dominated at the time by the global financial crisis. The campaign led to a growth in the awareness of the Carbon Pollution Reduction Scheme from 64% to 75% (Australia Department of Climate Change, 2009). In Cambodia, as part of the Climate Change Strengthening and Awareness Raising Programme, the National Council for Sustainable Development and the Ministry of Environment collaborated to produce reports in 2010, 2015 and 2020 on public perceptions of knowledge, attitudes and practices to inform the design of future awareness-raising and intervention efforts (Cambodia Ministry of Environment, 2020).

BOX 8:

Cities are taking part in informal learning initiatives to influence behaviour

Cities are key population and thought centres at the forefront of climate action, often leading awareness efforts with an action orientation. An analysis of climate actions taken by 96 cities, which make up the C40 group of cities with over 650 million inhabitants, found that awareness and educational campaigns were the third-most common action taken by cities to combat climate change. Examples range from bottom-up initiatives in Sydney, Australia, where peer learning networks enhance residents' environmental performance on energy and waste, to education campaigns in Medellin, Colombia, which included residents planting native trees (Sancino et al., 2022).

Cities are building climate awareness and capacity by providing training and knowledge programmes. In Buenos Aires, the Citizens Ready against Climate Change programme, which began in 2017, aims to raise awareness about climate change and resilience through mass communication campaigns. The Lago Lugano reserve project focuses on rehabilitating land damaged by human activity with the help of environmental education programmes that enabled sharing knowledge on the importance of conserving and regenerating the urban natural environment (C40 Knowledge Hub, 2019). In Dakar, a three-part civic outreach approach has, since 2017, involved 'green ambassadors' from the science and arts community, communication in schools and through the media, and training on relevant issues (McKinsey Sustainability and C-40 Cities, 2021).

Some cities at the forefront of championing sustainability have strongly embedded learning into transformation efforts. In Curitiba, Brazil, programmes to encourage community responsibility for the care and maintenance of urban spaces have historically used schools to promote ecological knowledge (Taniguchi, 2005). As part of the Curitiba 2035 strategic plan, developed in 2017, one of nine priority themes to achieve inclusivity, environmental sustainability and growth is to make Curitiba a city of education and knowledge (Spinosa and Costa, 2020).

In Copenhagen, the focus has been on adapting public space, encouraging renewable energy and supporting cleaner mobility infrastructure focused on cycling and public transport. The promotion of a cycling culture was achieved through a comprehensive approach that included cycling training and testing in schools, alongside infrastructure design, safety regulatory standards, and incentives that promoted cycling and prevented car use (Pucher and Buehler, 2008). About 80% of Dutch schools voluntarily participate in a national cycle testing programme for children, which focuses on practical, on-road cycling skills in addition to classroom safety lessons. The planning process is transparent and collaborative and has been updated through research, evaluation and citizen engagement every two years since 1996 (Buehler and Pucher, 2021). Educating residents in Montreal, Canada, about the ecological transition is a key action of the Montreal Climate Plan 2020–2030. The plan envisages the use of cultural and scientific institutions for awareness activities, catalysing youth for major change, and an annual awareness campaign on heatwaves targeted at the most vulnerable groups (Montreal, 2020).

TARGETED COMMUNICATION CAMPAIGNS ACCOMPANIED BY INCENTIVES INFLUENCE BEHAVIOUR

Climate behaviours and actions can be influenced not only by general but also through targeted communication that is accompanied by incentives and other interventions to engage the general public. Analysis of behavioural interventions targeting energy efficiency highlights the need to use multiple levers: simplified information, feedback mechanisms, social norms and comparisons, goal setting, rewards, and smart default options (Cornago, 2021). A meta-analysis of 84 communication campaigns in 18 countries found that they improved knowledge about solutions, belief in the benefits from these solutions and new behaviours. However, only providing knowledge was not a strong predictor of behaviour changes. A combination of interventions, coupling knowledge with interpersonal, peer-to-peer communication, was more likely to influence attitudes and behaviours (Green et al., 2019).

A combination of tailored information, feedback and goal setting helped increase knowledge and encourage energy conservation in Egypt. The Ministry of Electricity chose the message 'You are the solution. Don't be too lazy to turn off an appliance'. Highlighting other benefits, such as health, well-being and comfort, can help people relate to the topic. In Japan, the Ministry of Environment worked with 4 utility companies to send quarterly reports with personalized energy use information to 300,000 households. Households receiving reports used 2% less energy (Motherway et al., 2022). The 'Let's live warmer' campaign in Lithuania increased the number of applications for home renovations by four times between 2009 and 2011.

In Switzerland, a part of carbon tax revenues is redistributed as dividends, which are deducted from mandatory health insurance premiums. As only 12% of people were aware they had been receiving climate dividends, this solution initially failed to capture attention. In a large-scale experiment, half of the participants received information on how the climate dividend works and on how much money they saved through the policy, while the other half received no information. The analysis showed that informing the public about the climate dividend once it is installed could increase acceptance of a carbon tax (Jenny and Betsch, 2022).

Several campaigns focus on carbon footprint tracking to help people understand their use of resources and

motivate action. The Global Footprint Network has developed a personal calculator application. A survey of users revealed that 91% found it useful for generating knowledge and 78% for motivating action but only 23% indicated that it gave them enough information to make actual changes and reduce their personal footprint (Collins et al., 2020). Another analysis of online carbon footprint calculators found that 16% believed they had been effective in changing their daily energy consumption habits. The most effective calculators were both accurate and engaging, leading to higher use and better retention of knowledge (Mulrow et al., 2019). The EarthProject app, developed by Take Action Global with the Deloitte Corporation, helps users learn about climate change, motivate them to reduce carbon and plastic waste, and observe their impact on a daily basis. The application includes a focus on teachers and has been launched in schools in 142 countries (Take Action Global, 2023).

MONITORING AND EVALUATION OF CLIMATE CHANGE EDUCATION NEEDS TO BE FIT FOR PURPOSE

The relationship between education and climate change knowledge, attitudes and behaviours is complex. There are no straightforward indicators that help policymakers and the general public understand whether countries are making progress in addressing climate change education. There are trade-offs between simple and complicated indicators, light and intensive data collection methods, objective and subjective measures, and policy intention and actual implementation. A simple focus on educational achievement is insufficient.

Recent and upcoming rounds of PISA and TIMSS aim to go beyond knowledge to better understand attitudes and behaviours. The 2022 PISA includes climate change-related items such as the application of mathematics to the natural world and understanding of rapid growth phenomena (OECD, 2018). The 2025 PISA science assessment will focus on essential competencies for 'agency in the Anthropocene', reflecting on ways of being and acting within the world that position people as part of ecosystems, acknowledging and respecting all species and the interdependence of life. Competencies include explaining the impact of human interactions with Earth's systems, making informed decisions to act, applying creative and systems thinking, and demonstrating respect for diverse perspectives in seeking solutions to socio-ecological crises (White et al., 2023).

The 2023 TIMSS environmental attitudes and behaviours framework builds on cognitive items but includes non-cognitive constructs. Students are asked about responsible behaviours such as reuse or telling friends when they engage in behaviours that harm the natural environment. Science teachers are asked about how they teach sustainability and promote environmentally responsible behaviour and whether education about sustainability should be a priority for schools. Head teachers are asked about the extent to which the school engages in activities that promote environmental sustainability. Parents are asked whether they talk to their children about environmental issues or show them how to practise environmentally responsible behaviour (IEA, 2022).

Given that most countries are unlikely to take part in such cross-national assessments of achievement any time soon, a focus on policy intentions is a more realistic prospect. But even such endeavours have been challenged.

Attempts since 2015 to define and monitor SDG global indicator 4.7.1, the only relevant indicator in the 2030 Agenda, are indicative of the magnitude of the challenge. The indicator aims to measure the 'extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in: (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment'. Key challenges relate to the breadth of educational outcomes of interest; the breadth of the education mechanisms and potential channels being assessed; and the limitations of the preferred data collection methodology, which is based on self-reporting. It is, therefore, not surprising that efforts to measure the indicator have fallen short. The survey tool yields information that is neither comparable nor useful for policy (Benavot and Williams, 2023).

In recent years, three initiatives have been trying to define and measure alternative climate change education indicators, which represent complementary visions on what should be monitored (Table 2). Each initiative separately and all three jointly are trying to identify and propose one indicator that would overcome the weaknesses of SDG global indicator 4.7.1.

The *Greening Education Partnership*, launched at the UN Transforming Education Summit in September 2022, is structured around four pillars of transformative action: schools, curriculum, teacher training and

education system capacities, and communities. Each pillar has a distinct goal with potential underpinning indicators that need to be unpacked, for instance by defining green schools, climate-ready and climate-proof learning environments, holistic teaching and learning, and school collaboration with communities (UNESCO and UNFCCC, 2023). Under the Partnership, UNESCO is developing guidance for two of the four pillars. First, a Greening Curriculum Guidance will support countries to effectively integrate climate change education into their education systems, shaping how climate change should be taught and learned in classrooms and beyond, focusing on essential learning outcomes for different age groups, while addressing topics related to environmental, social and economic aspects of climate change, such as climate science, climate justice, and post-carbon economies. Second, a Green School Quality Standard will set the essential technical benchmarks for a climate-ready green school. It concentrates on integrating climate change and sustainability in four areas: teaching and learning, which emphasizes the importance of action-oriented and experiential learning; school facilities and operations; school governance; and community engagement. The standard aims to assist accreditation schemes (e.g. school certification and label grants or awards for good practices) and also provide guidance for policymakers and educators.

The MECCE project, launched in 2020 with over 100 partners and collaborators, is working to create a strong evidence base to support the implementation of climate change communication and education including through a suite of global indicators and accompanying data sets. Indicator development has followed a life-cycle approach for a range of climate change communication and education elements (as outlined in UNFCCC processes), sectors, participant types and indicator types. Data sources are evaluated against quality criteria such as geographic coverage and representation and the availability of trend data. The project released nine indicators for COP27 in 2022 and another five for COP28 in 2023, while more are under development. An integrated framework of robust but differentiated indicators is critical to properly capture the complexity of climate change communication and education and the range of relevant sectors and age levels.

A collaboration between the MECCE project and the GEM Report has also resulted in 80 country profiles, each of which analyses the context for climate

TABLE 2:

Monitoring indicators on climate change education proposed by selected initiatives

Greening Education Partnership	MECCE project	GEM Report PEER/MECCE country profiles
<p>1. <i>Greening schools:</i> All countries will have adopted a greening school accreditation scheme with at least 50% of schools, colleges and universities with green accreditation and operating sustainably</p> <p>2. <i>Greening curriculum:</i> The number of countries which include climate education in school curricula at the pre-primary, primary and secondary levels will have increased from the current level of 45%</p> <p>3. <i>Greening teacher training and education system capacities:</i> All school leaders and at least one teacher per school will have been trained on how to integrate climate education into teaching and learning throughout the school</p> <p>4. <i>Greening communities:</i> All countries are expected to be able to report at least three different ways which learning opportunities are made available for adults outside the formal education system to foster community resilience and tackle climate change</p>	<p><i>Primary and secondary education</i></p> <p>1. Integration of climate change into national curriculum policy</p> <p>2. Integration of climate change into grade 3, 6 and 9 science and social science syllabi</p> <p>3. Student's self-declared knowledge on climate change</p> <p><i>Higher education</i></p> <p>4. Extent of climate change focus in research publications</p> <p><i>Training</i></p> <p>5. Integration of climate change into technical/vocational training policy</p> <p>6. Completion of online courses on climate change</p> <p><i>Public awareness</i></p> <p>7. Perceived impact of climate change on future generations</p> <p>8. Perception of climate change as a serious threat</p> <p><i>Public access to information</i></p> <p>9. Availability of information on climate change impacts</p> <p>10. Public perception of frequency of exposure to climate change information</p> <p>11. Extent of climate activities organized by libraries and library associations</p> <p><i>Public participation</i></p> <p>12. Adult willingness to participate in climate action</p> <p>13. Extent that NGOs engage and inform the public on climate change</p> <p><i>Cross-cutting</i></p> <p>14. Inclusion index of climate communication and education in national government activities</p>	<p><i>Climate change context</i></p> <p>1. Inclusion of climate change in national curriculum frameworks</p> <p>2. Intention in the Nationally Determined Contributions to include climate change in the formal education curriculum</p> <p><i>Climate change education and training</i></p> <p>3. Laws, policies or plans include primary or secondary education</p> <p>4. Laws, policies or plans include higher education</p> <p>5. Laws, policies or plans include TVET</p> <p>6. Laws, policies or plans include teacher training for climate change</p> <p>7. Climate change education included in budgets</p> <p><i>Climate change communication</i></p> <p>8. Laws, policies or plans with a focus on public awareness of climate change</p> <p>9. Laws, policies or plans with a focus on public access to information on climate change</p> <p><i>Monitoring and evaluation</i></p> <p>10. Monitoring infrastructure/mechanisms to track climate change education</p> <p>11. Reporting on SDG 4.7.1/12.8.1 and 13.3.1</p>

Notes: GEM Report: Global Education Monitoring Report; MECCE: Monitoring and Evaluating Climate Communication and Education Project; PEER: Profiles Enhancing Education Reviews; TVET: Technical and vocational education and training.

change communication and education; climate change education policies and curriculum at all levels; climate change communication, including public awareness, public access to education and public participation; and monitoring and evaluation. The profiles also serve as a foundation for developing indicators to enable benchmarking and target-setting.

IT IS TIME TO PROPOSE A FRAMEWORK FOR A NEW INDICATOR ON GREEN CURRICULA

The GEM Report, MECCE and UNESCO have converged into one proposal for a headline indicator, in response to a decision by the SDG 4 High-level Steering Committee in December 2022 to have a benchmark indicator developed that captures progress in realizing the commitments for greening education made at the Transforming Education Summit. The Steering

Committee also called on all Member States ‘to set national targets’ once such an indicator has been developed and agreed upon.

The purpose of the proposed indicator is to assess the extent to which green content is prioritized and integrated into national curriculum frameworks and the syllabi of science and social science subjects in grades 3, 6 and 9. In particular, more than 30 keywords, organized in three clusters (environment, sustainability and climate change) were searched (Table 3) in nearly 1,500 curriculum documents collected from over 90 countries in all seven SDG regions (MECCE, 2024). Up to four curriculum documents were collected in the sciences and up to four in the social sciences for each grade, as well as any curricula specifically focused on the environment (e.g. environmental education).

The keyword search was carried out in 30 languages. All keywords were initially translated and then validated by language proficient experts. For 24 languages, the keyword searches were carried out using a qualitative data management software, while in the remaining 6 languages, which could not be read by the software, manual searches of keywords were conducted by trained, language proficient, coders. Altogether around 19,000 keywords were identified: 66% related to environment, 24% to sustainability and 10% to climate change. The number of references was summed separately by category (environment, sustainability

or climate change), knowledge domain (science, social science), grade level (3, 6 and 9) and then standardized through dividing them by the total number of words in the documents in that reporting category for each country, multiplied by 1,000,000. All documents for a country with a federated education system were combined prior to standardization.

As an entry point for discussion, data from standardized references were used to examine five indicators:

- Three indicators used references only from the primary and secondary education syllabi: one for the science domain, one for the social science domain, and one aggregate for both domains.
- Two indicators used references from the primary and secondary education syllabi and the national curriculum framework: one sums green content whereby references in all documents are added together before being standardized; and the other sums green content whereby the documents are standardized at each grade level before being averaged together.

The number of countries included in these proposed indicators varies between 76 and 80 due to missing information in one or more data sources. The indicators are reported using two scales: according to an absolute scale of the values of standardized references; and according to a ordinal scale consisting of five

TABLE 3:
Environment, sustainability, and climate change keywords searched, by cluster

Clusters	Keywords			
Environment	<ul style="list-style-type: none"> ■ environmental ■ ecosystem* 	<ul style="list-style-type: none"> ■ biodiversity ■ greening 	<ul style="list-style-type: none"> ■ green curricul* ■ blue curricul* 	
Sustainability	<ul style="list-style-type: none"> ■ education for sustainability 	<ul style="list-style-type: none"> ■ sustainable development 	<ul style="list-style-type: none"> ■ ESD 	
Climate change	<ul style="list-style-type: none"> ■ climate change ■ global warming ■ climate crisis ■ climate action ■ greenhouse gas ■ GHG emission ■ carbon dioxide / CO2 emission 	<ul style="list-style-type: none"> ■ climate hazard ■ climate impact ■ climate vulnerab* ■ renewable energy ■ climate resilien* ■ carbon footprint" 	<ul style="list-style-type: none"> ■ low emission ■ net-zero emission ■ carbon neutral" ■ just transition ■ climate justice ■ climate change impact 	<ul style="list-style-type: none"> ■ adaptation (within 15 words of 'climate') ■ mitigation (within 15 words of 'climate')

Note: Asterisks indicate that all declensions were searched (e.g., green curricula and green curriculum), as well as singular and plural variations of the term (e.g., climate action and climate actions).

categories: no focus (0 per million words); very low focus (1-300 words per million words); low focus (301-1,000 words per million words); moderate focus (1,001-10,000 words per million words); and high focus (at least 10,001 words per million words); no country achieved that latter level.

On average, the mean number of standardized references increases by grade (from 745 in grade 3, to 1187 in grade 6 and 1242 in grade 9 per million words) and is higher in subject syllabi than in national curriculum frameworks (where there are 649 standardized references). Although the standardized references in grades 6 and 9 have similar median values, a few countries have substantially more references in grade 9 documents (e.g. Indonesia, Marshall Islands, Mauritius, Slovenia, and Switzerland). In general, there are closer associations between the number of standardized references in the syllabi of the three grades than between the syllabi and the national curriculum frameworks. The number of standardized references is also higher in science than in social science syllabi. For instance, there are 43% of countries with a moderate focus in social science syllabi and 51% of countries with a moderate focus in science syllabi.

There is considerable variation in indicator values by SDG region. These values tend to be consistently higher in Central and Southern Asia and in Oceania, while they are consistently lower in Northern Africa and Western Asia and in sub-Saharan Africa. Europe and Northern America includes more green content in sciences, while Eastern and South-Eastern Asia also includes more green content in social sciences, when data for primary and secondary education are combined. In general, countries with higher income do not have consistently higher overall values than countries with lower income. Similarly, the most vulnerable countries on the Notre Dame Climate Vulnerability Index do not have the highest overall values as might have been anticipated.

Following this exploration of the data, a number of considerations emerged. First, should data from national curriculum frameworks, often drafted by policy experts, and syllabi, prepared by subject specialists, be combined? In principle, it is attractive to combine information. Doing so conveys the message that relevant official documents should be aligned. However, composite indices should ideally summarize information from inter-related sources, a fact that was not confirmed in the analysis. One possible reason for the weak association between the two sources

is that the writers who prepare curricular policy overviews and the experts who prepare curricular guidance for teachers have different target audiences and purposes in mind. Another reason may be due to policy incoherence. There may be a lag between policy pronouncements and curriculum content revision in accordance with new policy guidelines. Whatever the reason for the weak association, an indicator that combines data from weakly aligned documents may mask distinct strengths or weaknesses. Separating data from curriculum documents and subject syllabi into two distinct indicators would provide an opportunity to better understand the policy implementation dynamics of countries.

Second, at which level should keyword data be aggregated for reporting? Is it better to estimate standardized references in each document separately and then average across all documents in a relevant category or country, or to estimate standardized references, for example by grade, and then average these figures for a country's overall value? Aggregating data by grade is important since the intended curriculum differs considerably as children go through their education trajectory. Averaging standardized references across all documents in a country would bias the resulting indicator towards the results of particular grades and document types.

Third, should different components of a possible indicator be weighted differently? For example, a case can be made for assigning a higher value when countries integrate green content in every grade, especially considering that there is a tendency to assign less emphasis to climate change in early primary grades. Likewise, a case can be made for assigning higher value to the indicator when a country makes explicit references to certain keywords like 'climate change' or 'biodiversity' in their curricular policy and subject-specific documents.

Fourth, there are aspects related to clarity in communication, especially when combining data to establish an index. Any indicator proposal should be easily understood and accompanied by suggestions of steps countries can take to make progress. Using a scale that pits one country against another would undermine a message that each country can take steps to improve their status on a green curriculum indicator. Countries may be more supportive when there is clear information about each component of an index.

Fifth, the proposed approach opens an important window towards understanding how countries approach greening education. But simple counts of keywords cannot convey a nuanced understanding of how such content is embedded in each subject knowledge domain and grade level, let alone how it is translated into cognitive, socio-emotional and behavioural learning domains. Up until recently, it has been necessary to engage trained experts in time-consuming work to carry out such analyses, but the growing availability of sophisticated natural language processing programmes may gradually lower these costs.

Sixth, it is also important to ask in what directions an ideal indicator would need to move in the future to help us understand better whether we are “getting ever learner climate ready” in the words of the Transforming Education Summit’s outcomes declaration. One direction would be to expand the collection and analysis of curricular materials in other subjects, grade levels or type of content. Another might involve the compilation of textbooks to obtain a deeper understanding of how green content is embedded.

Reflecting on these points, it is recommended that an indicator should:

- capture green content in both subject curricula and national curriculum frameworks, giving greater weight given to the former over the latter;
- include information from all grades (starting with 3, 6 and 9), for both the sciences and social sciences; and
- give more weight to keywords related to climate change and biodiversity over those related to environment and sustainability.

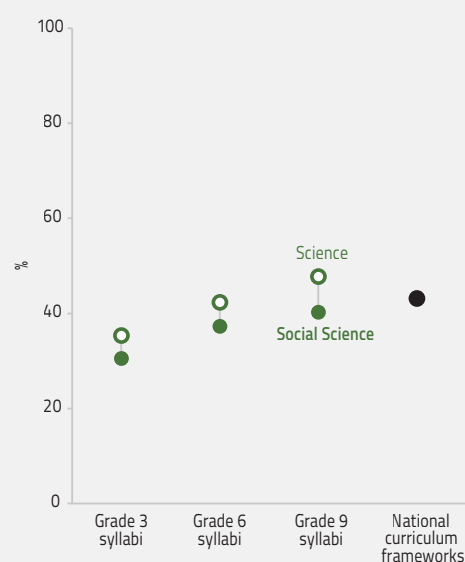
A proposed indicator for the consideration of Member States could therefore assign:

- a 25% weight to national curriculum frameworks and a 75% to subject curricula (or 25% to each grade);
- equal weight within each grade level to science and social science subject curricula (while splitting interdisciplinary subjects such as environmental education equally between the two domains); and
- a 70% weight to the more numerous environmental and sustainability keywords and 15% each to biodiversity and climate change keywords; and

Applying this methodology for 76 countries, standardized references were calculated for grades 3, 6 and 9 and for the national curriculum frameworks. Unlike the indicators discussed earlier in this section, this proposed indicator has been weighted and scaled so that the resulting values or scores range between 0 and 100. The results show that this new indicator has mean value of 40. The values (as measured by the average percentage of the maximum score for that category) much lower for keywords related to biodiversity (12) and climate change (21). Likewise, grade 3 has a lower green content (35 in science and 31 in social science) than grade 9 (48 in science and 40 in social science) (Figure 7).

The proposed indicator is a strong candidate not only as a benchmark indicator in response to the Transforming Education Summit but also for shifting attention away from self-reporting to a method that is based on objective data and expert guidance, with good potential to make the approach more sophisticated in coming years. The proposed indicator provides a balanced perspective across document types,

FIGURE 7:
Green content is more common in higher than in lower grades and in science than in social science subjects
Average percentage of the maximum score among countries, by grade and knowledge domain, 2023



Source: MECCE (2024).

knowledge domains and topical areas to capture the intended mainstreaming of greening education. It gives more weight to countries explicitly addressing climate change and biodiversity. Constructed along a scale from 0 to 100, the scores are easily understood and lend themselves to encouraging specific country actions to improve the greening education process. It may also be considered as a potential replacement for SDG global indicator 13.3.1, which in its original formulation focused on the integration of “mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula”.

RECOMMENDATIONS: EDUCATION MUST ADAPT TO BE INTRINSIC TO THE CLIMATE CHANGE AGENDA

Progress on climate change must involve education and communication of good quality. A growing collective of education advocates are highlighting the need to prioritize and fund climate change education. The Global Youth Statement, developed for COP27, synthesized demands from consultations with youth from 149 countries and made policy demands across 15 themes. National policy ambitions are growing around climate change education integration into the curriculum, as is a focus on awareness and communication. Global efforts, political commitments and collective action are propelled through the Greening Education Partnership. Education financing initiatives are also beginning to focus more on climate: the Global Partnership for Education Climate Smart Education Systems Initiative aims to push for mainstreaming of climate change adaptation and environmental sustainability into education sector plans, budgets and strategies (GPE, 2023).

However, existing analyses of education systems suggest that they are not fulfilling their potential to motivate action that supports climate change mitigation and adaptation. When assessing the situation from the perspective of the broader climate community, climate action policies currently do not prioritize education (McKenzie, 2021; UNESCO, 2019). Out of 140 Nationally Determined Contributions documents analysed, 77% referenced education, but only 31% specifically referenced the education of children and youth (Kwauk, 2022). A content and network analysis of interlinkages between the actions of transnational climate initiatives and the SDGs found that SDG 4 was addressed in only 2 of these 72 initiatives (Coenen et al., 2022).

Education to enhance professional capacity development for all SDGs is also not highlighted. An analysis of systemic transformation needs for energy, manufacturing, transport, urban planning, construction, food, agriculture, forestry, land management, oceans and freshwater management sectors highlighted 40 indicators to be tracked. However, none of these indicators explicitly mentioned education (Boehm et al., 2023).

Thus, much progress remains to be achieved to deliver the type and content of education that will enable the kind of transformative changes young people are demanding. Four issues need to be addressed.

Shift the paradigm so that education can rise up to the demands posed by the climate change challenge. Climate change education needs to be more deeply integrated into the curriculum, across multiple subjects and with adequate educator training support. But education also needs to change from an individualist focus on cognitive learning outcomes to social-emotional and action-oriented learning. Adding more learning content about climate change is needed but will not be sufficient without addressing the reasons for which such learning has not had concrete results so far. The focus of action needs to extend beyond individual to collective and system-wide responses to the climate change challenge. Educational responses also need to extend beyond teaching and learning to whole-institution approaches that also reduce the education system footprint.

More large-scale research as well as research into good practices will be needed to advance this argument and guide policy toward structural and viable reforms. The paucity of research on countries that are the most vulnerable to climate change is a major concern. Research must be used to identify which pedagogical interventions have greater impacts on changing behaviour and lead to proposals that improve classroom organization, pedagogy, teaching and learning materials, and teacher education. It is, therefore, recommended to:

- Implement scaled-up active pedagogy interventions and carry out ambitious research on their effectiveness in linking experiential knowledge with behavioural change.
- Reorient current monitoring efforts to measures that have not assumed but demonstrated links with improved behaviour and can guide policy makers to reform education systems.

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- Reorient current evaluation efforts of climate change communication and education programmes to focus away from numbers reached and towards process, implementation, engagement and impact.

Recognize education for its role in developing mitigation and adaptation solutions to climate change challenges. Education plays a key but underestimated role in building the professional capacities needed for climate change. Showing how capacity-building interventions help improve adaptation and mitigation practices is key to promoting collaboration between education and other sectors and for education to find the space it deserves in climate change conversations. It is, therefore, recommended to:

- Recognize the role of TVET and higher education institutions in providing the skills required to transform sectors and enable the transition to a green, circular and regenerative economy.
- Improve intersectoral coordination and ensure that integrated climate change action plans include financing for skills and capacity development.

Include investment in education under climate finance programmes. Education tends to be dismissed as a solution to climate change given its association with consumption growth and a larger carbon footprint. Yet education does help people develop and support mitigation and adaptation solutions to climate change challenges. Moreover, education's impact on fertility reduction remains vital and could be a strong argument for using climate finance to invest in education. It is, therefore, recommended to:

- Engage with non-education stakeholders for education to be included in climate plans and financing, in recognition of its role in climate change mitigation and adaptation solutions.
- Highlight the investment gap for (climate change) education in low- and middle-income countries.

Commit to monitor efforts to greening education, starting with the curriculum. A decision was made by the international community to monitor the commitment made at the Transforming Education Summit to green education. This report presents a proposal by the GEM Report, the MECCE project and UNESCO that uses the texts of national curriculum frameworks and subject syllabi in grades 3, 6 and 9 to assess the emphasis countries are placing into environment, sustainability, climate change and biodiversity. It is recommended that countries:

- Debate and agree on the proposed indicator methodology, while they consider future improvements.
- Embark on a process to provide their documents for analysis.
- Consider setting national targets on the agreed indicator for 2030.

References can be downloaded at the following link:
<https://bit.ly/ccec2024-ref>

Education and climate change

Learning to act for people and planet

Climate change and its impacts, including global warming and biodiversity loss, are existential threats. It is commonly believed that education has a critical role to play in climate change adaptation and mitigation. Yet a positive association between education attainment and unsustainable consumption levels, as well as inconclusiveness of much research on the direct impact of education on climate change adaptation and mitigation actions has contributed to education receiving low priority in the global and national climate change agendas.

This needs to change. Education plays a clear, if somewhat underappreciated, role in developing professional capacities needed for the transition to a green, circular and regenerative economy. But this report also argues that climate change education needs to adapt to fulfil its potential. The education paradigm cannot rely solely on knowledge transfer but needs to focus on social-emotional, action-oriented learning. Research on which approaches work best needs to be scaled up to inform policy change.

This report is the result of an ongoing partnership between the Global Education Monitoring (GEM) Report and the Monitoring and Evaluating Climate Communication and Education (MECCE) Project. It is the first in a new series of publications by the GEM Report aimed at advancing research and monitoring of the inter-relationship between education and other Sustainable Development Goals (SDGs). For that reason, this report also explores concerns about climate change-related impacts on education development.

Active global citizens worldwide are eager to take action to address climate change – and education is one of the most powerful tools they can have. We support the call to action by this paper and call on governments to prioritize investing in educating the next generation of active global citizens and to equip young people with the tools and resources they need to contribute to a sustainable and resilient future.

AFS International Programs

The clock is ticking. Like this report finds, we need to tackle climate change and build resilient communities of active global citizens for enduring action and impact.

World Wide Fund for Nature (WWF)

This is a much needed thought leadership piece. It rightly emphasizes interlinkages and synergies among different SDGs that must be leveraged to accelerate progress on the 2030 Agenda.

UN Department of Economic and Social Affairs

This paper is one of the most comprehensive treatments unpacking education's implications for the climate change agenda. The report is a wake-up call for policymakers – from all sectors – to find innovative ways to embed education in their strategies to address climate change.

Columbia Climate School

This comprehensive paper urges world leaders and climate experts to understand and better incorporate the human transition needs – education, skilling and behaviour change – in approaches to transform systems of energy use, land and water management, agricultural adaptation, and more.

Systems Change Lab

Evaluations expand our understanding of which climate change interventions work and warrant further investment. We are pleased that the paper calls for rigorous evaluations to bridge the evidence gap regarding the nature and type of climate change education that can be impactful in engaging youth and adults in climate action.

Mathematica



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Global Education
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