

ARTICLE

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Climate Change Education for Mitigation and Adaptation

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Abstract

This article makes the case for the education sector an untapped opportunity to combat climate change. It sets forth a definition of Climate Change Education for Sustainable Development that is comprehensive and multidisciplinary and asserts that it must not only include relevant content knowledge on climate change, environmental and social issues, disaster risk reduction, and sustainable consumption and lifestyles, but also a focus on the institutional environment in which that content is learned to ensure that schools and education systems themselves are climate-proofed and resilient as well as sustainable and green. The article presents evidence-based findings on the factors that influence skills, attitude and behaviour change the most, in order to determine what works for formal and non-formal climate change education content, including environmental education, climate change and scientific literacy, and education for sustainable lifestyles and consumption. The evidence shows that educational interventions are most successful when they focus on local, tangible, and actionable aspects of sustainable development, climate change and environmental education, especially those that can be addressed by individual behaviour. Finally, given that the majority of evidence that exists is anecdotal, often in case study format without monitoring and evaluation processes in place that could lead to quantitative as well as qualitative data, the article highlights remaining questions and areas of research that need to be investigated in order to guide effective climate change education policy and practice.

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Climate change threatens to undo and even reverse the progress made towards meeting the Millennium Development Goals and poses one of the most serious challenges to achieving sustainable development for the international community. According to the United Nations International Panel on Climate Change (UNIPCC), the continued changing climate will have widespread effects on human life and ecosystems. Climate change has already changed the magnitude and frequency of extreme weather as it is a key causative factor in increased heat waves, flooding, droughts, intense tropical cyclones, rising sea levels and loss of biodiversity. These hazards increase vulnerability to disasters and result in widespread human, material, economic and environmental losses (Intergovernmental Panel on Climate Change 2012).

Vulnerable groups like children living in poverty in low-income countries with weak governance and poor education systems are the hardest hit by climate change. The effects of the physical consequences—more frequent extreme weather, melting glaciers and shorter growing seasons—add to existing pressure on these societies. Over the long term, these effects combined with factors such as population pressure are likely to lead to environmental degradation and deterioration in livelihoods, as well as exacerbate existing socio-economic tensions and create new ones. This will have implications for migration, stability and security at local, national, regional and global levels (United Nations Office for the Coordination of Humanitarian Affairs [UNOCHA] 2009: 15).

CLIMATE CHANGE MITIGATION AND ADAPTATION

There are two main strategies to address climate change: mitigation and adaptation. 'Mitigation' focuses on interventions to reduce greenhouse gas (GHG) concentrations through measures that cut GHG emissions or move carbon out of the atmosphere, which can range from investment in clean energies to forest conservation. Mitigation measures aim to stabilise and reduce the amount of GHGs in the atmosphere, thereby stopping many of the negative impacts of climate change.

However, with sufficient GHG concentrations already in the atmosphere, some effects of climate change will continue despite mitigation. Therefore, 'adaptation'—reducing the vulnerability of natural and human systems to the impacts of climate change and adapting to a changing climate through adjustments in social, ecological or economic systems—is also essential.

THE CASE FOR CLIMATE CHANGE EDUCATION FOR SUSTAINABLE DEVELOPMENT

The changing climate is making it harder to deliver quality education and to keep learners safe while doing it. Disasters induced by climate change can damage or

destroy school facilities and educational systems, threatening the physical safety and psychological well-being of communities and interrupting educational continuity. Furthermore, the economic impacts of disasters reduce school enrolment, as children are kept out of school to help with livelihoods.

Despite being threatened by climate change, the education sector offers a currently untapped opportunity to combat climate change. Since the causes of climate change are at least partly linked to human actions, these actions need to be identified and changed. This involves learning to change consumption patterns, such as using renewable forms of energy and designing greener technologies. Thus, mitigation requires education geared towards learning how to change lifestyles, economies and social structures that are based on excessive GHG production. Education can show people that, as conscious consumers and responsible citizens, they have a critical role to play in redefining their lifestyles to address the current sustainability issues that humanity is facing. In addition to education's integral role in individual behaviour change for mitigation, learning centres and schools have a role to play in mitigation in terms of becoming carbon neutral, energy efficient and reducing their own ecological footprint.

Given the unpredictability of climate change, the challenge is not simply adapting from one stable climate to another, but adapting to an uncertain climatic future. This demands an approach to adaptation that not only manages current risks and uncertainties but also fosters adaptive capacity. Adaptation is, therefore, not a choice between reducing general vulnerability and gaining the knowledge needed to learn about, prepare for and respond to specific hazards. Rather, adaptation requires both. Education is a critical component of adaptive capacity. The way that people are educated and the content of education can provide the knowledge and skills needed for making informed decisions about how to adapt individual lives and livelihoods as well as ecological, social or economic systems in a changing environment.

There is a clear education agenda in climate change adaptation and mitigation strategies, which require learning new knowledge and skills and changing behaviours in order to reduce vulnerabilities; manage the risks of climate change; change consumption and production patterns; and build adaptive capacity and resilient societies.

DEFINING CLIMATE CHANGE EDUCATION FOR SUSTAINABLE DEVELOPMENT

Education for sustainable development (ESD) is an approach to teaching and learning based on the ideals and principles that underlie sustainability and applicable to all types, levels and settings of education. As such, ESD promotes multi-stakeholder social learning; emphasises the empowerment of communities and citizens; engages with key issues such as human rights, poverty reduction, sustainable livelihoods, environmental education and gender equality in an integral way; and encourages changes in behaviour that will create a more sustainable future. Climate change education is therefore a subject that fits well within the ESD agenda.

Climate change education has been narrowly defined in certain contexts as focusing on climate literacy and environmental education within science class. However,

climate change education for sustainable development must be comprehensive and multidisciplinary; it must not only include relevant content knowledge on climate change, environmental and social issues, disaster risk reduction and sustainable consumption and lifestyles, but it should also focus on the institutional environment in which that content is learned to ensure that schools and education systems themselves are climate-proofed and resilient as well as sustainable and green.

Based on this, there are two components of climate change education for sustainable development that are critical across all levels, types and settings of learning:

1. Relevant skills and content knowledge, including critical thinking, problem solving and collaboration around environmental education, climate change and scientific literacy; education for sustainable lifestyles and consumption; disaster risk reduction and preparedness; and green technical and vocational education and training.
2. Safe, climate resilient and sustainable learning spaces.

There are also two cross-cutting issues that are crucial to realising each of these two climate change education components: (a) the active participation of the community, especially children and youth, as agents of change; and (b) enhanced linkages between education policy-makers and climate researchers to ground educational policy and actions in scientific knowledge and expertise (Anderson 2010). If implemented in a comprehensive manner within an ESD approach, these components, which are explained in more detail next, can build the capacity of education systems and individuals to help shape and sustain future action about climate change and other uncertainties.¹

Relevant Skills and Content Knowledge for Climate Change Education

A central function of education is to foster learning new subjects and skills. Teaching and learning should integrate environmental stewardship, which encompasses environmental education; climate change and scientific literacy; disaster risk reduction and preparedness; and education for sustainable lifestyles and consumption. Learners need a basic understanding of scientific concepts with a deeper level of systems thinking, such as:

- knowledge of the history and causes of climate change; knowledge of and ability to distinguish between certainties, uncertainties, risks and consequences of environmental degradation, disasters and climate change;
- knowledge of mitigation and adaptation practices that can contribute to building resilience and sustainability; and
- understanding of different interests that shape different responses to climate change and ability to critically judge the validity of these interests in relation to the public good.

Teaching and learning about all of these should draw on both scientific and indigenous knowledge for successful mitigation and adaptation (United Nations Educational,

Scientific and Cultural Organization [UNESCO] 2009). In particular, higher education can promote relevant scientific knowledge and expertise and support the development of adaptive technologies.

Given the uncertainty that climate change brings, it is not enough to integrate relevant knowledge such as environmental and climate change education into curricula. Education should also cultivate the necessary skills for climate change education, within the larger context of twenty-first century lives and livelihoods: critical thinking; problem solving; and collaboration across all subjects and in the development and maintenance of safe and sustainable schools. Critical thinking and problem solving require issue analysis and decision-making, which help individuals and groups learn about their problem(s) from multiple perspectives, identify options for change and use this information to create an action plan to address those problems (McKeown and Hopkins 2010: 17–21). These skills are essential for developing and sustaining adaptive capacity because these skills can enable learners to comprehend, analyse and use information to think creatively and change behaviour in order to adapt to different futures (Association for the Development of Education in Africa [ADEA] 2010). A central component in this effort to develop critical thinking skills is to create education systems that equip learners with the requisite skills, knowledge and attitudes to deal with future uncertainties and challenges, including climate change. Enhancing teachers' own knowledge and their capacities to strengthen learners' capacity for critical thinking is essential. This requires teacher education, with a focus on the faculty of teacher education institutions, in content areas and in learner centred, participatory and inclusive instruction.

Safe, Climate Resilient and Sustainable Learning Spaces

In order to ensure that educational gains are not lost as climate change-induced storms, floods, etc., destroy infrastructure, learning spaces should be made safe and climate resilient through the incorporation of disaster prevention, preparedness, response and recovery strategies for individuals, educational systems and communities. Disaster risk reduction strategies ensure the safety and continuity of education, helping the system to adapt to climate change and reduce the vulnerability of learners. Safe school sites can be selected through participatory risk assessments geared at ensuring that every new school is climate-proofed and multi-hazard resilient. This requires prioritising replacement and retrofit of unsafe schools and minimising non-structural risks. A critical element in enhancing resilience is the ability to prepare for and respond to the impacts of climate change. Students, teachers, parents and communities must be involved in practising early warning, simulation drills and evacuation for expected and recurring disasters. Education systems also need to work with parents and the wider community to adapt as necessary to the seasonality changes caused by climate change through strategies such as adapting the school year, exam calendar and textbook distribution.

To ensure adaptive and safe learning environments, schools can develop contingency plans for continuity of learning in the event of unexpected disasters and/or displacement caused by impacts of climate change. One concrete framework for doing this is the Inter-Agency Network for Education in Emergencies (INEE)

Minimum Standards for Education: Preparedness, Response, Recovery. Moreover, safe and adaptive learning environments, and contingency planning within them, can be models for the communities in which they sit.

In addition, schools and education institutions should be made sustainable through environmentally sound and carbon-neutral policies that promote mitigation through building and site design and maintenance. There are millions of schools around the world and ensuring they reduce their own ecological footprint is one way that education policy can contribute to sustainable development and climate change mitigation efforts. This requires design, building, management (including procurement) and maintenance practices geared towards carbon neutral and environmentally sustainable learning spaces, which integrate green technology to reduce energy consumption. For example, climate change can increase water stress caused by erratic rainfall patterns and create a need for alternative sources of water. Programmes for harvesting rainwater can be integrated into schools so that children have a safe and ready supply of drinking water and basic sanitation facilities at school. School-based water and sanitation programmes also have the benefit of encouraging parents and the community to support children, especially girls, going to school. Such schools are not only a contribution to sustainable development itself, but also contribute to the ‘whole school approach’ as they act as a resource and good practice model for teaching and learning about sustainability and sustainable consumption.

Defined as such, climate change education is instrumental to the sustainable development goal of meeting the needs of the present without compromising the ability of future generations to meet their own needs. As world leaders prepare to meet at the United Nations Conference on Sustainable Development (Rio + 20) in June 2012 to assess progress towards internationally agreed goals on sustainable development, secure renewed political commitment, and influence a new set of sustainable development goals, climate change education for sustainable development should be promoted as an area that addresses not only the issues of climate change mitigation and adaptation, but also the green economy, sustainable consumption, ecosystems protection, energy efficiency and disaster risk reduction.

EVIDENCE-BASED FINDINGS ON WHAT WORKS IN CLIMATE CHANGE EDUCATION

In 2011, the Brookings Institution’s Center for Universal Education worked with a team of graduate students at Columbia University and New York University, to review evidence-based research that assesses what factors influence skills, attitude and behaviour change the most, in order to determine what works for formal and non-formal climate change education content. Literature reviews were carried out on the following keywords, which are critical elements of the relevant content areas of climate change education:²

- climate change education;³
- environmental education;⁴
- climate change and scientific literacy;⁵ and
- education for sustainable lifestyles and consumption.⁶

The research team focused on research based on scholarly methods and in-depth evidence published in scientific, peer-reviewed journals as well as monitoring reports, assessments and evaluations of climate change education projects.⁷ Researchers also triangulated their findings with qualitative assessments, research-based arguments, socio-political critiques and theoretical frameworks that include anecdotal evidence and report on trends and practices.

It is important to note several limitations of this effort, most notably the lack of evidence-based research related to climate change education impacts on behaviour change. Much of the research conducted in the broad field of climate change education focuses on qualitative or theoretical analysis and anecdotal evidence, rather than evidence. In fact, while the literature review process initially included the subject of green technical and vocational education and training, no credible evidence-based research studies were found for this theme, and thus the findings and recommendations in this article do not include this topic. Other limitations include:

1. The vast majority of evidence-based research results focus on research carried out in Europe, the United States (US), Canada and Australia. Very little evidence-based research was found for developing countries.
2. Small sample sizes and limited trials lead to few statistically representative sample sizes, which preclude researchers from conducting statistical analysis or being able to draw conclusions. Moreover, as most evidence-based research on climate change education has been focused on a particular location (mainly within a developed country) that is not representative of global demographics (particularly in terms of education and exposure to climate change), generalisation is not automatic.
3. There is a dearth of longitudinal studies regarding the long-term behaviour changes expected from climate change education programmes.

Given the latter two limitations and the multi-component nature of education in general, it can be exceedingly difficult to correctly identify a correlation between successful learning outcomes and long-term behaviour change and exposure to climate change education.

Nevertheless, several common findings on what works across the areas of climate change education, climate science and literacy, environmental education and education for sustainable lifestyles and consumption repeatedly emerged from a diverse array of evidence-based studies. While the scientific dynamics of climate change are unmistakably complex in the eyes of both students and teachers, educational efforts frequently succeed in overcoming this complexity to generate positive outcomes. Several studies find that a better understanding of climate change science has positive consequences, including that students with a greater understanding of science report more awareness of environmental issues and a deeper sense of responsibility (Bybee 2008; Hartley et al. 2011; Hoody 1995). Moreover, as detailed next, climate change educational interventions are most successful when they focus on local, tangible and actionable aspects of climate change, especially those that can be addressed by individual behaviour. Based on the findings of evidence-based research, the following recommendations emerge.

RECOMMENDATIONS FOR CLIMATE CHANGE EDUCATION TEACHING AND LEARNING

Based on the review of evidence-based research, the following recommendations emerge for teaching and learning about climate change education.

Climate change literacy can be improved through *sustained, active learning activities using integrated, cross-discipline curricula*. An integrated, cross-discipline curriculum grounded in the application and practicality of climate and environmental science, and that provides continuity over the years, would allow students to connect various aspects and models of environmental and climate science to one another, thereby enabling them to integrate their knowledge into their understanding of climate change and their own role in it (Bybee 2008; Charusombat et al. 2011; Crowther and Robinson 2001; Hoody 1995; Jin et al. 2009). It is critical that climate change education is not introduced as a separate, stand-alone subject area, or solely within the science section, but instead integrated across existing subject areas such as science, citizenship education, geography, social studies, history, language, drama and the arts.

Active learning should be connected to local problem solving. Hands-on educational activities with a local focus seem to create successful learning outcomes, especially when integrated into a regular school curriculum (Pruneau et al. 2003). Educational techniques that connect climate change with not only local issues but also individual behaviour and impacts offer tremendous promise, both by making abstract concepts tangible and by linking the global phenomenon to individual actions (Fortner and Duan 2005). Moreover, climate change education efforts that include overt links to sustainable development can make local impacts more evident, both in developed and developing countries (Jenkins and Jenkins 2005; Segovia and Galang 2002).

While climate change education should inform students about the scientific concepts and implications of climate change, it is also important to *cultivate problem solving and critical thinking skills through framing messages to emphasise an individual's capacity to achieve positive outcomes* (Morton et al. 2001; Spence and Pidgeon 2010). Additionally, shifting towards motivational framing, with a focus on solutions and values, improves climate change engagement and intent to adopt adaptive behaviours (Gifford and Comeau 2011). The framing of climate change messages, whether in education programmes or awareness-raising campaigns, so as to promote a sense of self-efficacy (the ability to effect change) and empowerment encourages individual action towards climate change. While increased knowledge of climate change significantly increases concern about climate change, delivering a climate change message that empowers an individual with effective actions decreases participant fear and uncertainty due to an increased feeling of capacity to effect change (Morton et al. 2001; Taber and Taylor 2009). One caveat that is important to note in this respect is climate change education for young children, within which the framing of the climate change message is extremely important. Recent studies have shown that overexposure to issues related to climate change lead to an increased sense of helplessness and demotivation (Kefford 2006: 582; Nicholson-Cole 2005).

Problem solving-based education can increase the degree to which students behave in a sustainable manner if learners are presented with *information and behaviour change options whereby concrete gains can be made to reduce individual footprints* (Brody and Ryu 2006; Howell 2006; Stall-Meadows and Herbert 2011). When learners can see or understand a direct result of their actions, it is easier to obtain results. It is important therefore to *include measurement tools, such as carbon and ecological footprint calculators, with climate change education* so that learners can track the changes they can make/are making/will make over time (Brandon 1999; Brody and Ryu 2006).

Narrative techniques, visual imagery (such as photographs) *and persuasive texts* are powerful tools that have been shown to be successful at enabling students to engage with complex scientific subjects such as climate change; make global climate dynamics more understandable and engaging for students; and impact students' attitudes and willingness to change behaviour (Niepold et al. 2008; Schmidt and Wolfe 2009; Segovia and Galang 2002; Sinatra et al. 2011). Evidence-based research and many guidelines emphasise the use of technology for dissemination of knowledge, with the caveat that unless the programme is age appropriate, engaging and relevant, it may be confusing and do more harm than good (Mohtar et al. 2007; Niepold et al. 2008; Peloso 2007; Volk and Cheak 2003).

Teacher education is essential for providing quality climate change education. Like with learners, linking climate change and environmental education to relevant and tangible issues improves their own understating of the foundational concepts as well as their value of the subject. In research in India, for instance, teachers gained a better grounding in the subject area once they were dissuaded from the idea of the subject as only academic. Instead, once teachers understood the local relevance of the subject to learners' everyday lives and livelihoods, they had more positive attitudes about the subject and were better equipped to teach it (Sonowal 2009). Moreover, in a 2011 study, teachers claimed that inciting changes in student behaviour was the greatest benefit of teaching about climate change, more so than other factors such as improving scientific understanding. As such, educational modules that focus on links between individual behaviour patterns and climate change are more likely to have significant buy-in from teachers, possibly improving educational outcomes (Hestness et al. 2011).

Relatively short and simple curricular modules seem to be impactful in pre-service teacher training efforts about climate change education. In a recent study, prospective teachers who enrolled in a teacher training course at an American university were asked to rate their preparedness to teach about climate change. The average rating was 2.95 on a scale of 1 to 7. After only two class sessions devoted to climate change, totaling less than four hours, the percentage of prospective teachers who identified conceptual difficulty as a challenge in teaching about climate change fell from 21.25 to 7.23 per cent (Hestness et al. 2011).

RECOMMENDATIONS FOR FUTURE RESEARCH

While the evidence-based findings and recommendations presented in the previous section as to what works for climate change education are important, there are many remaining questions and thus areas of research that need to be investigated in

order to guide effective policy and practice. Climate change education is a relatively new area of study and best practices in the field are only beginning to emerge. The majority of evidence that exists is anecdotal, often in case study format, without monitoring and evaluation processes in place that could lead to quantitative as well as qualitative data. The following recommendations require stronger collaboration amongst academics, agencies and networks across the education, climate change and sustainable development communities to strengthen the evidence base on the most effective adaptation and mitigation measures through education and their impact at individual, school and society levels:

1. The development of a standardised framework of objectives, knowledge, skills and measurable outcomes of climate change education is essential in order to evaluate what works, and then, use that information to revise strategies and raise global awareness about what can and should be done through climate change education to ensure sustainable development.
2. More and more rigorous, evidence-based research on education as an effective tool to mitigate and adapt to climate change, both in terms of cost and in terms of outcomes. Most evidence-based studies involve initial assessments of student knowledge gathered by means of questionnaires or interviews, followed by educational interventions and post-intervention assessments. While this model is useful, many studies struggle to balance qualitative and quantitative elements within assessments, leading to statistical findings with limited meaning or conclusions dependent on overly subjective data interpretation. In general, there is a need for additional evidence-based research and for replications of studies that have proven successful.
3. More longitudinal studies are needed to determine a correlation between positive behaviour change and exposure to climate change education programmes and activities.
4. Future research should focus on what specific tools produce positive educational outcomes in numerous and diverse settings.
5. Evidence-based research is needed on not only climate change education teaching and learning outcomes, but also outcomes of relevant, safe, adaptive and green education, and on education system safety and continuity.
6. A myriad of climate change education curricula resource guides and policy toolkits exist; their use needs to be tracked and educational outcomes evaluated.

A SELECTION OF CLIMATE CHANGE EDUCATION TEACHING AND LEARNING RESOURCES⁸

1. **Children in a Changing Climate** is a hub for learning resources and activities for children and those working with children to explore the local and global dimensions of preventing and adapting to climate change. The 'Learning' page allows visitors to browse the database for resources to facilitate teaching and learning on climate change and disasters (<http://www.childreninachangingclimate.org/Learning.htm>).

2. **Climate Change Education.org** is designed for both educators and students. This clearinghouse offers an extensive collection of classroom-oriented resources (lesson plans, activities, games and videos) on the subject of climate change (<http://www.climatechangeeducation.org/>).
3. **Climate 4 Classrooms** offers teaching and learning resources that enable students to learn about the science of climate change, investigate possible global and national futures and explore global and local solutions. Each module has clear learning outcomes, activity plans and student activity sheets (<http://uk.climate4classrooms.org/teaching-resources>).
4. **Environmental education** is a multi-disciplinary approach and process that teaches people to learn about and investigate their environment, and to make intelligent, informed decisions as an individual and as part of a group about how they can take care of it.
5. **Eco-Schools USA Climate Change Pathway** provides guidance and resources for schools and students groups to incorporate climate change education into curriculum, reduce their carbon footprints and in the process, develop science, math, technology and social science skills. It includes sample teaching and learning resources for 'Climate Classroom', a National Wildlife Federation initiative that focuses on creating age and developmentally appropriate curricula and projects that educate youth about the causes of and remedies for global warming (<http://www.nwf.org/Global-Warming/School-Solutions/Eco-Schools-USA/Become-an-Eco-School/Pathways/Climate-Change.aspx>).
6. **Facing the Future's Climate Change and Energy Resources** for teaching and learning about climate change and energy include topics such as emissions, GHGs and energy conservation. It also includes 'Climate Change: Connections and Solutions' curricula for Grades 6–7 and Grades 9–12 to encourage students to learn and think critically about climate change within a systems framework; examine interconnections among environmental, social and economic issues; and to collaborate to devise solutions (<http://www.facingthefuture.org/GlobalIssuesResources/GlobalIssueResources/ClimateChangeEnergy/tabid/240/Default.aspx>).
7. **National Environmental Education Week**, a programme of the National Environmental Education Foundation, offers hundreds of resources for educators—lesson plans, videos, professional development opportunities and information on grants and awards—on a variety of topics, including climate change. In particular, a page on 'Climate Change Curricula' provides a link to science-based, grade-appropriate teaching materials on climate change (http://eeweek.org/resources/climate_curricula.htm) and a page of 'Climate Change Resources' provides links to educational tools, information and organisations with objective, scientific information on the earth's climate (http://eeweek.org/resources/climate_change.htm).
8. **Oxfam Education Resources on Climate Change** provide climate change educators with case studies of various programmes being implemented in developing countries, together with related lesson plans and activities (<http://www.oxfam.org.uk/education/resources/category.htm?20>).

9. **A Student's Guide to Global Climate Change** is a kid-friendly website that provides students and educators with information about the causes and effects of climate change as well as steps to take to help solve the problem. The website also offers a set of 'Educator Resources', including 'Tips for Educators' to enable educators to create lessons, and 'Additional Web Resources' on climate change, energy and related topics for both students and for educators (<http://epa.gov/climatechange/kids/>).
10. **Teaching Climate Change: Lessons from the Past** is a comprehensive website that provides educators with teaching and learning materials, including lesson plan ideas and visual aids (<http://serc.carleton.edu/NAGTWorkshops/climatechange/recommended.html>).
11. **UNESCO's Climate Change Pedagogical Resources** page presents teaching and learning resources for primary and secondary schools that cover both the science behind global warming as well as strategies for adapting to and mitigating the impacts of climate change (<http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/climate-change-education/cce-clearinghouse/pedagogical-resources/>).

Notes

1. This list of components has been simplified due to space limitations in this journal; for a more comprehensive overview of a climate change education framework, see Anderson (2010).
2. Unpublished literature reviews were developed in 2011 for the Brookings Institution's Center for Universal Education by Derek Sylvan, Columbia University School of International and Public Affairs ('Climate Change Education'); Anna Moffett, Steinhardt School of Culture, Education and Human Development ('Climate Change Education'); Rahima Bensaid, Columbia University School of International and Public Affairs ('Climate Change and Scientific Literacy'); Catalina Spinel, Columbia University School of International and Public Affairs ('Education for Sustainable Lifestyles and Consumption'); Muhammad Waqas Halim, Columbia University School of International and Public Affairs ('Environmental Education'); and Waqas Rana, Columbia University School of International and Public Affairs ('Green TEVT'). A literature review on evidence-based research on what works for disaster risk reduction education was not undertaken to avoid duplication of work that is in progress by the International Strategy for Disaster Reduction's Thematic Platform on Knowledge and Education (ISDR TPKE).
3. Climate change education is a broad category within which a number of academic studies have attempted to assess individuals' levels of knowledge about climate change, and also determine what works in the field of climate change education. Typically, evidence-based research in this field focuses on measuring changes in student knowledge after the implementation of a particular educational module or programme.
4. Environmental education, defined by Schoenfeld and Disinger, is 'lifelong, inter-disciplinary approach to the development of the world that is aware of and concerned about the environmental and its associated problems which has the knowledge, skills, motivations and commitment to work individually and collectively to the solutions of current problems and the prevention of the new ones'.
5. Climate science literacy is defined within *Climate Literacy: The Essential Principles of Climate Science* as one's understanding of their influence on climate and climate's influence on themselves and society.

6. Sustainable lifestyles and consumption are defined as 'patterns of action and consumption... which meet basic needs, provide a better quality of life, minimise the use of natural resources and emissions of waste and pollutants over the lifecycle, and do not jeopardise the needs of future generations' (Scott 2009).
7. While this effort strove to include available articles that address relevant evidence-based research, the sources selected do not represent an exhaustive review of the existing literature.
8. These websites are in English; for climate change education materials in French and Spanish, see Botanic Gardens Conservation International (BGCI), 'Resources for Communicating about Climate Change', available at http://www.bgci.org/education/climate_change_communication/

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