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Abstract. *This paper outlines the contribution the education sector can provide in meeting the challenges of climate change, worldwide. It offers an analysis of the means via which education, awareness and training can help the global efforts to tackle climate change and lists a set of practical activities which may assist various groups in handling climate matters as part of formal and non-formal education. The paper concludes by providing a warning: without proper emphasis to educational approaches, the desired (and indeed) changes in attitudes and behaviour as well as the motivation needed in order to engage people in reducing the impacts they may have on the climate, may not be fully achieved.*

Key words: *climate change, formal and non-formal education, active learning.*

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THE CONTRIBUTION OF EDUCATION TOWARDS MEETING THE CHALLENGES OF CLIMATE CHANGE

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Introduction: Defining Climate Change and its Links with Individual Behaviour

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as:

"... a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."
(UNFCCC, 1992, p.3)

Climate change can, as stated by Leal Filho (2009), be regarded as:

- a process which studies the implications of climate variations;
- a phenomenon influenced by natural processes and by human activities;
- an issue with impacts on nature and on quality of life; and
- a problem with wide-ranging economic and social implications.

Although climate change is on the one hand to a great extent influenced by natural phenomena such as ocean currents, emissions from volcanoes or the normal climate variability, it is on the other heavily influenced by human activities. Indeed, specific anthropogenic behaviour, such as that listed below, is regarded as being closely related to the acceleration of climate change.



- deforestation (for land clearance and the wood/paper industry)
- intensive farming (releasing methane)
- intensive use of fossil fuels (for power generation and transport)

Closer analysis reveals that these behaviours are really the outward manifestation of an underlying issue: overconsumption of resources that sends these behaviours in overdrive. Overconsumption of Earth resources by developed countries has been identified as the cause of all these ills. If unsustainable lifestyles and consumption patterns are not addressed and challenged with the evidence, then efforts would just be targeting symptoms and paying lip-service to climate change.

Table 1 outlines some of the human-led processes which have been leading to climate change.

Table 1. Some of the human-led processes associated with climate change.

Process	Consequences
Growth in industrial activities	Higher concentrations of greenhouse gases in general in the atmosphere
Intensive use of fossil fuels	Higher concentrations of CO ₂ in the atmosphere
Uncontrolled emissions from businesses, households, transport	Exacerbation of the greenhouse effects; raising of sea levels; changes in habitats
Burning of rainforests	Higher concentrations of CO ₂ in the atmosphere and destruction of tropical habitats

The seriousness of the problem of climate change can perhaps be better understood if one considers the fact that increases in the global temperatures may lead to changes in habitats and ecosystems as well as in level of precipitations (IPCC 2007). It will also have substantial economic implications (Stern, 2007). Therefore, climate change is not only a serious a problem per se, but it is also a problem with many ramifications with far reaching negative impacts on the quality of life as shown in Table 2.

Bearing in mind that education, awareness and training can play a lead role in changing behaviours (Leal Filho, Manolas, Pace, 2008) and that communication on climate change is greatly needed (Leal Filho, 2009), these aspects will be analysed in the next section of this paper.

Table 2. Some of the impacts of climate change.

Environmental impacts	Social impacts	Economic impacts
<ul style="list-style-type: none"> • Freak weather • Melting of polar caps • Increase in sea-water level • Drought and forest fires • Loss of biodiversity • Loss of agricultural land 	<ul style="list-style-type: none"> • Health issues and spread of diseases • Increase in poverty • Increase in the rich/poor divide • Increase in migration of environmental refugees • Regional conflicts over limited resources 	<ul style="list-style-type: none"> • Changes in tourism patterns • Negative impact on agriculture • Changes in im/exportation patterns • Increase in insurance premiums due to an increase in damage claims

If one takes the problems seen in respect of rainforests for example, it can be seen that a new, increased focus is needed in order to sustain and perhaps give a new momentum on the debate on their role in the processes associated with climate change (Leal Filho, 2008 and 2009). The on-going destruction of the world's rainforests, especially by means of fires, worsens a problem which is already serious enough and which deserves immediate action.

This state of affairs illustrates the fact that climate change is a global problem which needs solutions both at the global and the regional/local level. It is also a problem which can be best dealt with if people are made aware of the connections between climate change and personal behaviour at schools and universities (Rappaport and Creighton, 2007) but also elsewhere. No matter where they live or work, persons may exert a (personal) influence on the climate, by means of:

- the way they travel (i.e. less planes, more public transport);



- ii. the way they use energy (i.e. saving energy as opposed to wasting it); and
- iii. the preference they give to renewable energy (i.e. more use of renewable energy and less use of energy from fossil fuels).

Admittedly, the level of impact of a single individual is difficult to measure. However, when taken in context and as a percentage of a country's population, it becomes clear that the desired impact of individual action is indeed being yielded. If one considers the example of Sweden, a country where around 90% of the energy use derives from renewable sources (with one of the world's largest car fleets running on ethanol), one can see that individual behaviour can have an influence on climate change.

The Contribution of Education and Awareness-raising in Dealing with Climate Change

Although the important role of education has always been earmarked – particularly in international conventions – as an essential measure that promotes sustainable development (UNESCO, 1980; UNESCO-UNEP, 1988; Scoullos, 1998; UNESCO, 2005; Centre for Environment Education, 2007), experience has shown that educational campaigns are most often either taken for granted or given marginal importance. Consequently, weakly conceived educational campaigns do not deliver the targets that they purportedly had to address.

The main emphasis of any educational campaign should be on learning not on teaching; i.e. the learner not the information to be conveyed. This implies considering the individual as an active citizen – irrespective of age, gender, race, social role and responsibility – contributing and participating in decision making. Education is the means through which the individual is empowered – through the acquisition of knowledge and skills as well as the development of attitudes and values – to develop a sustainable development ethic. This ethic ensures that sustainable development always features in the individual's concerns: whether deciding upon adopting a particular lifestyle or structuring policies of a national/entrepreneurial nature.

Whether at school or at university or at work or in the community, different levels of governance tend to consider citizens as passive followers expected to comply with policies rather than leaders capable of spearheading change at the different levels of society with which they interact. Consequently civil society is usually kept uninformed of the reasons why certain actions are needed and policies are usually presented as a *fait accompli*: having to take a prescribed medicine without being told why it is needed.

This type of approach tends to generate inactivity in the populace, focuses attention on short term results and erodes accountability and responsibility. This is a far cry from the concept of shared responsibility – between authority and citizens – that is at the root of sustainable development. Sustainable development cannot thrive in a context where citizens feel more comfortable with having someone to decide, think and provide for them. Long term achievements in sustainable development require individuals who are critical thinkers equipped with the required knowledge, skills and attitudes that promote action towards sustainable lifestyles. This can only be achieved by a well planned and implemented educational strategy.

Guiding principles

A backdrop of basic guiding principles needs to be ensured when developing an educational strategy for climate change:

(i) Accessibility of information

Climate change has already impacted human history by at least two major instants – spurring our evolution by inducing our ancestors to adopt new lifestyles that ensured their survival under the new conditions. Responding to climate change should be characterised primarily by the adoption of new ways of life (adaptation) that would help us live within a changed context (e.g. reduction in the availability of fossil fuels). Measures to alleviate the present pressures (mitigation) should be considered as short term solutions that sustain adaptation efforts.



Learning from one's (and other's) experiences is at the heart of our evolutionary process. Therefore, the provision of information is a necessary component in an educational campaign. This immediately highlights four major interrelated issues that need to be addressed:

(a) awareness about climate change needs to be more holistic, providing an all round understanding of the overt (e.g. freaky weather patterns and rise in sea level) and the covert (e.g. economic reverberations and health related issues) impacts of climate change. Most of the information currently being disseminated – particularly through the media – tends to highlight impacts that, albeit real, are relatively remote from the day to day experiences of learners. Considering the volume of information received daily, such 'inert' information may result in information overload. As damaging as lack of information, information overload needs to be avoided (Dalal-Clayton and Bass, 2002, p.239) as it overwhelms the individual and hinders assimilation, issue prioritisation and action focus (United Nations System-Wide Earthwatch, 2003). Rather than spurring citizens to take concrete actions, this lack of personal involvement will eventually result in citizen desensitisation about the issue. "*The threat of desensitization could prove one of the gravest threats of all*", (Podesta and Ogden, 2007, p.134).

(b) information about climate change is still hostage to the territorial behaviour of public entities. This phenomenon is particularly true to Small Island States and small communities/municipalities. Sharing and dissemination of information is generally reluctant, fragmentary and incomplete. Given the importance of this information, national authorities need to seriously consider the setting up of a national repository of environmental information organised by themes rather than ministerial/departmental responsibilities. This information bank would contain technical reports and official government/non-governmental documents about specific environmental issues. Besides acting as a one-stop shop for access of environmental information, this repository would reduce wastage of resources spent in duplicating information gathering.

(c) a fragmentary approach to the gathering (and provision) of information fails to identify specific lacunae in information – except when that information is urgently required. In that case, reparatory (and expensive) measures are usually taken to correct this shortcoming ... further increasing the fragmentary nature of the information gathered. The need for information gathering and communication would be more suitably addressed if efforts were channelled towards promoting local research and capacity building.

(d) to be truly accessible by all, information related to climate change needs to be processed in a way that people, at different levels of society, that are not familiar with scientific/technical jargon, can understand its meaning.

(ii) Catering for a variety of needs

Like all other environmental issues, climate change is (as previously commented) a multifaceted issue that has various inputs, solutions and approaches. Consequently, addressing climate change necessitates a strategy that approaches it from different angles with an educational campaign characterised by having different levels of engagement. Different individuals live in different contexts and face different realities and dilemmas responding differently to the challenges of climate change. An educational campaign has to respond to these different needs (Centre for Environment Education, 2007): ranging from, for example, understanding what an eco-label on an appliance means to learning how to reduce water consumption or from installing an energy efficient electrical system to changing procurement regulations in favour of environmentally friendly products.

Catering for diverse educational needs does not refer solely to bringing civil society in line with climate change issues. A major component of a nationwide educational campaign about climate change is the education of policy makers, managers/administrators and professionals (UNESCO-UNEP, 1988). In our societal structure, the impact of the decisions and practices of this cohort of individuals has a far reaching (and long term) effect on our sustainable future. Although, owing to their training, the educational level of these individuals is relatively higher than the mean educational level of the population, responding to climate change requires knowledge, skills and attitudes that might be lacking by individuals occupying these key roles, hence the need for re/training.



(iii) Lifelong education

Responding to change requires an educational process that continuously addresses emergent needs.

"Through education and lifelong learning we can achieve lifestyles based on economic and social justice, food security, ecological integrity, sustainable livelihoods, respect for all life forms and strong values that foster social cohesion, democracy and collective action." (UNESCO, 2009 a, Article 5)

It is, therefore, imperative that every citizen – irrespective of age, gender, race, social role and responsibility – has access to ESD. Lifelong ESD should be seen as the lifetime companion of the learner accompanying and sustaining him/her through the different contexts and situations that characterise a lifetime. Consequently, ESD programmes should, by default, be sensitive to the needs of the learner and flexible to adapt to these needs (UNESCO, 2009 a, Article 7).

Considering the importance of a lifelong ESD process in the development of a sustainable society, one would expect that national governments would be proactive in showing their serious commitment towards sustainable development by enshrining ESD provision within a national ESD policy. Nevertheless, irrespective of the politically correct and apologetic draft report for the World Conference on Education for Sustainable Development (UNESCO, 2009 b, p.3), a large percentage of countries have still not complied with this basic commitment (Committee on Environmental Policy, 2005).

(iv) Promoting good practice

Responding to climate change primarily requires a radical change in lifestyles and consumption patterns – a redefinition of practices that have been with us for quite sometime and have become part of our social fabric. This adaptation is difficult and for some – particularly those that are economically challenged – it is even harder. Consequently, a good educational strategy needs to promote, support and reward good practice. There are several ways how good practice can be incentivised, but a major aspect that needs to be sustained is consistency.

Citizens get particularly irritated and frustrated whenever they feel that they are being unjustly treated, i.e. when they perceive that certain individuals/organisations are above the law and are thus exempt from burden sharing. People in authority are expected to behave in a way that is congruent with the attitudes, values and lifestyles that they are trying to promote on a national basis.

Incentivising (facilitating) good practice and deterring (discouraging) wrong practice promotes citizen empowerment and shared responsibility. It also implies perceiving civil society as a colleague (partner) in decision making not as a client or a threat. Characteristically this would result in wide consultation, more burden sharing and a greater responsibility at the grassroots (consumer) level.

(v) Departing from the comfort zone

Breaking habits and doing things differently generates discomfort, particularly when practices that have stood the test of time (e.g. procurement/billing/importation regulations, how economics is conducted, how progress is measured) need to be replaced. Bureaucratic structures that tend to slow down action need to give way to structures that identify pre-empt and address change. Therefore, an educational programme needs to incorporate measures that develop critical learners who can deal with and respond to change.

Suggested actions

Although some might think that there are more efficient and 'clean' short cuts to gaining consensus about a climate change strategy, if civil society is not involved from the very start in policy making, the maintaining and running of policies will prove to be more laborious and time/resource consuming. Weav-



ing an educational and a wide consultative process within a climate change strategy might appear, in the short term, a waste of precious time. However, it is the surest way of achieving long term goals.

The list of techniques listed below, gathered from various sources, is certainly not exhaustive. All the techniques chosen consider every citizen as an active and valid actor in the climate change strategy and thus respect and value each citizen's contribution. They are also sensitive to the citizens' cultural and social backgrounds, hence avoiding the pitfalls of token participation. Another important note: the methods cited are tools, i.e. a means to an end NOT an end in itself.

a) Information dissemination techniques: **ensure accessibility of relevant environmental information needed for informed decision-making:**

- o **Newspapers/Magazines** – are a very efficient means of communication because they are a common feature in many households. Information can be achieved through (i) regular features (inserts); (ii) feature stories highlighting good practice and personal experiences; (iii) paid adverts and (iv) press releases.
- o **Fliers and brochures** – highlighting the major points of the issue, answering FAQs and providing contacts for more information. Distributed free of charge (either by hand or by post or by being included with utility bills) they can reach large numbers of individuals.
- o **Television/Radio** – can be used for sharing and disseminating information and eliciting reactions from the public through news bulletins, news conferences, documentaries and discussion programmes.
- o **Internet** – besides presenting readily assessable and downloadable information, it promotes communication and feedback about specific issues through (for example) bulletin boards, blogs, wikis and chat rooms. The major issue of concern with this method is that the information exchanged may not always be accurate.
- o **Speakers** – training a group of individuals that are well informed about climate change and sending them to give information talks to departments, clubs, organisations, etc.
- o **Panel of experts** – composed of people who are not only familiar with the issue, but are properly trained to answer questions and face awkward situations and hostile audiences. This panel can be asked to participate in discussions about the issue on the media.
- o **Information offices/desks** – having flexible opening hours that enable people to visit them and get first hand information. These information centres can also be equipped with a telephone or email hot line operated by personnel trained to deal with FAQs or automatically tuned to pre-recorded messages. In certain instances such centres can also offer technical assistance.
- o **Site visits** – the dimension and extent of an environmental issue are usually best conveyed by organising site visits for citizens to sites of particular importance.
- o **Info panels and bill boards** – are an effective way of conveying bite-sized information about climate change and practices. Furthermore, electronic info panels fixed to sensors can provide real-time information about, for example, emission levels and air quality, thus offering an opportunity to monitor the quality of the environment.
- o **The Climate Change Mobil** – containing educational material about climate change and resource persons can visit communities and provide community-based educational programmes.

b) Techniques encouraging input:

- o **Interviews** – although time consuming, these one-to-one meetings provide in-depth insights about specific (and also personal) aspects of climate change
- o **Personalised meetings** – involves visiting households and talking with the individuals living there
- o **Meeting small groups** – visiting small meetings of existing groups and initiate discussions aimed at gathering feedback
- o **Surveys** – are by far the most common form of data/response gathering methods. This



method is usually very effective when input from large groups is required. The most common forms include: (i) mailed questionnaires; (ii) fill-in response sheets usually distributed during information dissemination campaigns; (iii) telephone surveys and (iv) electronic surveys conducted over the internet or across computer networks

- o **Public hearings** – also used to gather feedback from large groups. They usually start off with a presentation about the issue and then the floor is opened for questions, clarifications and inputs.
- o **Smart bills** – providing benchmarks and incentives can be a very effective tool in helping individuals set targets that control their consumption patterns
- o **Carbon footprint calculators** – that reflect characteristic lifestyles help citizens to identify their impact on the environment and provide a readily available means of checking out the effectiveness of specific actions

Responding as a nation to climate change requires not just a paradigm shift in the technologies used and legislation adopted, but also in the way we perceive civil society and how we provide education. The former needs to acknowledge and invest in the role and input that civil society can make; and the latter needs to professionally cater and be structured around the needs and realities of the learner.

From Theory to Practice: the Importance of Climate Change Education in a Sustainability Education Context

In discussing the link between climate change education and sustainability, one needs to explain the meaning of a most important term in climate change education, that of empowerment. In our use of the word, empowerment is a prerequisite for action and includes content specific knowledge and cognitive skills, motivational patterns and personal value orientations. An empowered person feels capable of taking appropriate action to achieve what s/he aims for, and combines his/her cognitive resources (knowledge and skills) with affective resources (motivation, attitudes, hope and visions). This line of thinking also applies to climate change. Using results from surveys in Europe and Germany, as given by Kuckartz (2009), we may conclude that we still have a long way to go in order to have truly empowered persons with regard to climate change. Although 80 to 90% of those surveyed are sensitive about climate change, only 20 to 50% are knowledgeable about climate change and a much smaller percentage, 5 to 20%, actually takes action to combat the problem.

The section which follows outlines some examples of educational initiatives on climate change being undertaken in different parts of the world. These examples come from a variety of sources including abstracts, course outlines and scholarly articles. Besides focusing on the interdisciplinary nature of climate change issues, all the activities cited adopt learner centred pedagogies.

It should be noted that the engagement of people in activities such as the ones which follow is context specific which means that there will be variations from individual to individual, from group to group and from society to society. If this is the case then the engagement of people in such activities is essential for making progress in creating truly empowered persons as defined above.

The importance of the context specific nature of the activities which follow needs to be illustrated. For example, many of activities below require the identification and discussion of barriers to engagement as well as of facilitating and limiting factors to individual action against climate change. The existing literature (Kolmuss and Agyeman, 2002; Moser, 2006; Lorenzoni, Nicholson-Cole and Whitmarsh 2007; Moser, 2008; Spence and Pidgeon, 2009; Swim et al., 2009)) shows that such lists of barriers as well as lists of facilitating and limiting factors to individual action against climate change are certainly not complete. Therefore, for purposes of enriching the existing literature, the discovery, for instance, of new barriers to engagement or of different examples of a barrier, other than those already identified, is something which enlarges and enriches the particular concepts for the specific phenomenon because it reflects the essence of a larger quantity of instances of the phenomenon (Manoledakis, 1994). Some have even claimed that such individual experiences may even prove more revealing and innovative than the ones we already know (Page, 1959) and, can, therefore, be invaluable in advancing the frontiers of our knowledge in the specific fields they belong to.



Some Examples of Educational Initiatives

- **Carbon footprints and climate characters**

The course *Climate Change: Politics, Philosophy, and Public Policy in Action* (Jacobs, 2007), provides students with the opportunity of exploring the political intricacies of climate change and their impacts on populations. Students start off by calculating their daily personal carbon footprint and to extrapolate its value, in tons of carbon dioxide, for a year. They are then asked to compare their average per capita values (in the US) with those of other countries (EU-25, China and India) and to realise the relationship between emissions and lifestyles. In their coursework students are asked to delve deeper into the specifics of climate change by considering (i) specific lifestyles (or *climate characters*) and (ii) the “*common but differentiated responsibilities*” of nations vis-à-vis the impact on climate change of rich and poor countries.

- **Ethical aspects of climate change**

After having seen *An Inconvenient Truth*, university students enrolled in the course *Spirituality and Sustainability* (Warner, 2009) explore the ethical and moral dimensions of climate change through coursework. Students are expected to analyse and discuss the problem of climate change from a moral, ethical and religious perspective relating it to scientific, socio-political and economic perspectives. In conclusion, students are expected to translate their deliberations into action or stance.

- **Addressing knowledge gaps**

Although the provision of knowledge is no guarantee for a change in lifestyle and consumption patterns, misconceptions and knowledge gaps are conducive to wrong decision making. Uninformed actions against climate change may cause more harm than benefits. This is particularly relevant to universities where professionals and specialists – whose opinions will have an impact on climate change decision making – are trained.

Through the use of reflection rubrics, the Association of American Geographers identified gaps in basic knowledge about climate change, in university students and the general public, largely due to their information sources. In fact, their knowledge base was derived from information obtained from scientific sources and articles in populist magazines. In response, the Association set up the *Climate Literacy Initiative* aimed at addressing knowledge gaps and providing resources and professional development programmes (Dupigny-Giroux, 2007).

Climate and Culture (Heim, Voos and Shein, 2008) is a multidisciplinary course within a university Master degree that attempted to address the issue of knowledge gaps by exposing students to different sources of information. These included background reading material and guest speakers who were climate change specialists from various fields. Students could develop a wide knowledge base that integrated scientific, social and cultural perspectives of climate change. The success of this course has initiated another graduate course, entitled *Climate Change and Society*, adopting the same methodology.

- **Environmental politics in developing countries**

One of the frequently reported hitches that educational programmes about climate change face is that the knowledge provided is usually presented in a monodisciplinary format. Although students are expected to integrate the whole lot, experience and research have shown that they usually do not. Focusing on specific case studies is a way of helping students learn about climate change in an interdisciplinary way since the case studies usually present a set of interacting concerns.

By compiling a case-study, students following the course *Environmental Politics in Developing Countries* (Potter, 2008) explore in detail the realities of climate change in a specified poor country. Students are expected to analyse these realities and trace them to particular policies and decisions and consequently



understand the importance of good governance of resources. Throughout the course students develop research skills and learn how to handle and sift through the information available.

- **Experiential learning**

In an effort to make environmental issues, particularly climate change, more relevant and meaningful, Pruneau *et al.* (2005) exposed a sample of 11-12 year old students to a variety of learner centred methodologies including immersion in nature and role play. Through these activities students had the opportunity of experiencing nature firsthand and participate in decision making processes. The research results of this programme revealed greater student participation and an improved way of dealing with climate change issues.

In another research project, entitled *The Circle of Ecological Wisdom*, Pruneau *et al.* (2006) attempted to find ways how they could encourage teachers and their students to adopt climate change mitigating behaviours. After receiving inservice training about climate change and related methodologies, teachers were asked to choose and adopt mitigating behaviours. After reflecting on their experience, the teachers applied their own climate change education programme in class. The researchers concluded that experiential learning strategies that led learners to observe, interact and reflect on their changing surroundings, led to effective behaviour modification.

- **Valuing indigenous knowledge**

In an effort to reach communities, the Atmospheric Radiation Measurement Climate Research Facility (ACRF) installed interactive kiosks about climate change in rural and indigenous communities (Maestas and Jones, 2005). These kiosks are sites where the public can access scientific and indigenous knowledge about climate change through archived interview clips with ACRF scientists and community elders on various aspects of climate change. The initiative is particularly noteworthy in that it values the insights and perspectives of indigenous knowledge (developed through ages of observation, community experiences and wisdom) and manages to develop links with current scientific thought. The knowledge thus provided is sensitive to the community's needs and contextualised to its realities. Consequently, these kiosks have been very successful as outreach educational facilities.

- **Mock climate change negotiations**

The Department of Geography, Royal Holloway, University of London provides its students with an opportunity of experiencing the procedures and realities of international negotiations about environmental issues (Dengler, 2009) – realities that go beyond the 'logic' of scientific facts and enter the realm of political power, economic interests and social needs. Each student is assigned a country and then guided to understand its characteristics and interests. Students then engage in several sessions of lobbying and negotiations aimed at getting the best deal for their particular country. Eventually the various 'nations' propose their resolutions about climate change from which the most important proposal is chosen and voted for or against. The activity is then concluded with a guided discussion aimed at helping students to reflect on their experiences and thus understand the mechanisms involved in international environmental summits.

- **Teaching climate change through music**

Peter Weiss (2007) uses music and lyrics to create songs, intended to teach and inspire young children to make specific behavioural changes for the planet. Known as the Singing Scientist he delivers shows, school assemblies, science camps and radio programmes during which he effectively combines learning science with fun through his songs. The primary aim of his songs, as spelt out in his website (<http://www.peterweissmusic.com/>), is *Heal the Planet with Music and Science*.



- **Structured controversies**

Johnson and Johnson (1988) provide some guidelines as to how to engage students in a structured controversy. Students are split into groups of four with each pair within the group being assigned to one side of the issue. Each pair researches the issue and defends its position within the group. Then all four members of the group engage in a discussion where they refute the other side and rebut attacks. They then change roles and defend the opposite side. Finally, the group must synthesize all of the gathered material and reach a consensus on a position that they determine to be the best reasoned one. Finally, they write a report and/or present their position to the rest of the class.

This method is effectively used by Junior 8 Summit (or J8). This is a forum aimed at helping young people to think about, discuss and reach conclusions about global issues. The summit runs parallel to the G8 summit and participants get to present their collective concerns and recommendations to the world leaders attending the G8 summit. Participating schools are also provided with educational material that provides a sound knowledge base about the issues being discussed and develops argumentative skills (e.g. Climate Change Exercise, 2009).

- **Discussion using cartoons**

Cartoons are a powerful means of providing social and political commentary. They may or may not be humorous and can be designed to show all the vices or virtues associated with a particular character or event. They can be especially effective in calling attention to the ironies that surround our lives. They may also be biting in their comment on a social issue or in reference to a particular person. They usually use the techniques of symbolism and exaggeration to present forcefully particular points of view (Doring, 2000).

Cartoons may constitute suitable means for introducing the concept of the greenhouse effect, for reflecting and thinking about the issue of the greenhouse effect, for understanding a point of view, for developing skills in interpreting cartoons. Consider, for example, the following cartoon (TERI, 2007):

After an analysis of the symbolism and exaggeration in the cartoon as well as linking the cartoon with different scientific views on the greenhouse effect, students are asked to discuss the following questions: a) What are your emotions about the cartoon? Justify your answer. b) What do you think about the message offered in the cartoon? Do you agree or disagree? c) When was it more satisfying looking at the cartoon as a piece of art: before or after the interpretation of it? Why? d) If you were asked to change the cartoon, what part(s) would you change? Why? What parties would be opposed to the message communicated by the cartoon? Why? (Manolas and Filho, 2004)

Some Observations

In the pedagogical strategies discussed above the students are actively involved in the learning processes. They hear, see, exchange views and act. Generally, in contrast to passive methods of teaching, the involvement with the learning strategies presented earlier, requires more serious preparation and more effort by both teachers and students.

Many of the strategies presented address different learning patterns by providing diverse modalities how learning can occur. Also, students serve as models of improvement for one another while, at the same time such involvement increases each student's confidence regarding learning in both the cognitive and affective domains.

In addition, as seen in Table 3, active learning encourages life-long learning and may lead students to get more satisfaction from their studies as well as improve their critical and problem-solving skills. Both teachers and students should have no doubt that the planning and implementation of active learning activities such as those discussed in this paper require time and energy. But the rewards in the future may be too important to ignore.



Table 3. Advantages and disadvantages of active learning activities.

Active learning activities	Advantages	Disadvantages
Written essay assignments	They can groom peoples' writing style. They help students come up with their own thought provoking ideas. They can teach students quite a lot about form, structure and format.	Can be time consuming. Undue weight may be given to factors such style, syntax and grammar and not to the content of the assignment.
Reading assignments	Can be done at own pace and time. Enables learner to supplement the more formal instructional methods with specialist reading.	Instructor identifying appropriate reading material. Relies on learner motivation to act.
Observation in nature	Learner activity can be high. It provides direct information about the subject of study. Interest and motivation may be easily obtained and maintained. Can create greater and deeper understanding.	Can be time consuming. May not be effective if it is not carefully planned, thoughtfully implemented and followed up back at school.
Reflection rubrics	Students are able to self-assess their work. Students can understand better the rationale and the reason for engaging in the particular activity. They help improve student performance, because they know what to focus on.	Development of rubrics can be complex and time-consuming. Defining the correct set of criteria to define performance can be complex. Rubrics might need to be continuously revised.
Case studies	They encourage involvement. They help develop analytic and problem solving skills. They allow for exploration of solutions for complex issues. The allow students to apply new knowledge and skills.	They are time consuming to produce. They are difficult to validate when there is no quantifiable solution. Close relationship to 'real life' may be difficult to achieve.
Adoption of new mitigating behaviour	Provides opportunity to explore values, beliefs and habits and by so doing arrive at a rich and detailed account of barriers that block appropriate behaviours as well of factors that promote and motivate needed actions.	Requires a great deal of commitment by the person involved. Can be time consuming.
Creating and teaching own model of climate change education	Provides opportunity for deeper and greater exploration of barriers to appropriate behaviours and of ways to overcoming these barriers. The teaching part provides opportunities for exchange of ideas and feedback both of which can happen in a short period of time.	May not be effective if it is not carefully planned and thoughtfully implemented.
Visits	They allow for real world experiences. They allow students to learn outside of the classroom. They can bring students closer together.	They take an incredible amount of planning. They bring up a wide array of legal issues, most regarding liability.
Panels of climate specialists	Experts present different opinions. Can provoke better discussion than a one person discussion. Frequent change of speakers keeps attention from lagging.	Personalities may overshadow content. Experts may not be effective speakers. Subject may not be in logical order.
Outside guest speakers	Personalizes topic. Breaks down audience's stereotypes.	May not be good speakers.
Interviews with local community elders, regional agency officials and scientists	Can be useful for untangling complex topics. The interviewer can probe deeper into a response given by an interviewee.	Can be time consuming. The interviewer can affect the response of the interviewee if he/she is not consistent. The interviewer may be biased and ask closed questions.
Mock climate change negotiations	Introduces problem situation dramatically. Can be highly participative. Allows for exploration of solutions. Provides opportunity to practice skills. Participants may identify and accept more readily their own weaknesses. Mistakes can be made without fear of serious consequences. Quick feedback of results. Assists transfer of learning from theory to practice.	Competitive spirit and "desire to beat the umpire" may detract from the actual learning. Some students may feel threatened. Time consuming to produce. Processing the groups' decisions can be complex.



Active learning activities	Advantages	Disadvantages
Discussion	Interest can be quickly aroused. Pools ideas and experiences from group. Effective after an experience, e.g. a cartoon, that needs to be analysed. Allows everyone to participate in an active process.	Time consuming to obtain anything worthwhile. Not practical with more than 20 students. A few students can dominate. Some students may not participate. Has to be extremely well-controlled to be of value. Can get off the track.
Structured controversy	Both sides of an issue are explored in detail. Sharpens reasoning skills regarding what people believe.	It can get so heated that it deteriorates into an argument and there is no respectful listening to the opponent's side. It may close down thought, making an issue subject to just one or two points of view.
Role playing	Can create a great deal of interest. Active participation by role players. Provides a "living" example. Provides opportunities for students to assume roles of others and thus appreciate another point of view. Allows for exploration of solutions. Provides opportunity to practice skills.	Success depends on the imagination of the players. Not appropriate for large groups. Some students may feel threatened. Some people may find it too artificial and therefore may not give the necessary commitment. It is time consuming.

Conclusions

The problems caused by climate change do not differentiate between young and older people. However, bearing in mind that the consequences of climate change will be felt for years to come, it seems sensible to try to actively engage young people who will be most affected and for the longest period of time.

The various examples of educational approaches and methods to handle climate changes in education presented in this paper were chosen, because they promote discovery and give ownership of learning to the learner. Thus they make knowledge personal by contextualising it and actively involving the learner in finding solutions to what is a global problem, but one which also has strong regional and local impacts. Well conceived learner-centred education for sustainable development programmes focusing on climate change may manage to change the 'teacher' by requesting a different pedagogy from the traditional one. It may also encourage action in a non-formal education context, since much also may be achieved by fostering awareness on climate change out of formal education, as a complement to it.

It is in any case clear that in order to holistically tackle the various challenges climate change poses; a proper emphasis on educational approaches is needed. They are essential if any changes in attitudes or in behaviour may ever be achieved, both in the short and in the long-term.

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