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## Teaching ‘Sustainable Development’ at school level

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### Introduction

In the recent years, the world has undergone fundamental restructuring with increasing emphasis placed on scientific and technological advancement to improve the quality of living. However, some of the excessive developments and harmful scientific/technological inventions have also resulted in the imbalance of ecosystem which also threatens the Earth's life systems. The image of science has thus been tarnished by a succession of inconsiderate scientific and technological developments with unforeseen degradation of environmental or societal consequences and life-threatening hazards, such as the environmental pollution caused by chemicals e.g. DDT, CFCs and the depletion of ozone layer. Scientific developments have also led to public unease about their implications, among the examples are genetic manipulation and cloning. It was commented by expert that,

*“...To sustain a healthy and vibrant democracy, such issues do not require an acquiescent... public, but one with a broad understanding of major scientific ideas, who, whilst appreciating the value of science and its contribution to our culture, can engage critically with issues and arguments which involve scientific knowledge...”*

(Millar and Osborne, 1998, p.8)

How to achieve a civilized society consists of public with broad understanding of major scientific ideas appreciating the values of science? Obviously science education in the school curriculum plays the most vital role in this aspect. During the September 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa, The Soka Gakkai International (SGI) proposed the establishment of an international Decade of Education for Sustainable Development (DESD) to follow the UN Decade for Human Rights Education from the year 2005 to 2015. The objectives of the decade are to promote education as the basis for a sustainable human society and to strengthen international cooperation toward the dissemination of environmental information (Ikeda, 2002). A dedication to learning and a holistic education underpinned by a holistic ethics encompassing the integrated aspects of Science, Technology, Environment and Society (henceforth referred to as STES) could act as a model for a broader education which could play a fuller part in the social transformation critically needed in the 21<sup>st</sup> century. It is thus high time to incorporate the teaching of “Sustainable Development” into the existing school curriculum and this article explores how ESD could be practically implemented at the grass root level of science teaching.

## Concepts and Education For Sustainable Development

Sustainable development is defined as the development which increasingly meets basic needs of humans, *eradicating poverty* and *enhancing the quality of life* by incorporating *environmental concerns* into economic planning and *policies without depleting the matter and energy* of the ecosystem upon which development is founded. An economy which develops sustainability would be designed to perform at a level which would allow the underlying ecosystem to *function* and *renew* itself ceaselessly.

Education for Sustainable Development (henceforth referred to as ESD) involves the teaching of values and other moral ethics in STES education to ensure the creation of *sustainable environments* in which people can live and work, whereby:

“A *sustainable environment* is one in which the *natural environment*, *economic development* and *social life* are seen as mutually dependent - and the interaction between them contributes to the *sustainability* and enhancement of the quality of people’s lives and the natural environment.”

(Fien, 1995, p.2.5).

### Education for Sustainability: Various Concepts, Definitions, Issues and Key values

While there is much debate around the world about the means and mechanisms for achieving this transition, there seems to be wide agreement that *education* has an important role to play in transforming values as well as empowering individuals and groups to participate in *environmental improvement* and *protection*.

Sustainable development cannot exist as some static equilibrium state. Permanent *scientific* and *technological* innovation necessitate that sustainable development exists in some form of dynamic equilibrium. One of the reasons for this is the ongoing tension between *social* interests and *environmental* interests in practical sustainability projects (Robottom, 2003). As such, the aspects of *environmental sustainability* as well as *ecological and economic sustainability* should also be emphasized in the discussion of ESD.

This important role for *environmental* education was stressed in some of the major international reports on environmental problems in recent years. For example, the World Commission on Environment and Development (1987) argued that ‘the *world’s teachers* ... have a *crucial role to play*’ in helping to bring about ‘the extensive social changes’ needed for *socially and ecologically sustainable environments* (Fien, 1995, p.xiv).

Education *for* the *environment* thus stands in contrast with education *about* and *in/from* the environment which, through their strong content and field experience orientations, address only a limited number of these objectives. In contrast with education *about* and *in/from* the environment, education *for* the environment focuses on students working individually and in groups towards the resolution of environmental questions, issues and problems. Within the formal education sector of environmental education, this involves

many non-traditional approaches to teaching and learning, including what the World Commission on Environment and Development (1987) described as the ‘active involvement of students in the movement for a better environment’ (ibid, p.114).

Whereas the *key value* of **ecological and economic sustainability** derives from a recognition of the interrelationship between economies and environments. It is based on a belief in the integrity of environments, their importance as the basic source of life support, and the wise, equitable and sustainable use of resources. This *key value* emphasizes the promotion and attainment of ecological, *sustainable development*; the complex nature of environments; and the need to protect environments for their intrinsic value, for their heritage values, and as a resource to sustain life in the present and for future generations. It should be noted that where reference is made in the syllabus to environments, it embraces the natural, social and built elements.

**Ecological and economic sustainability** involves acting ethically towards the **environment** by establishing and maintaining social, political and economic structures which are focused on finding a quality of life in a world of limits. The *key value* of ecological and economic sustainability will involve students understanding, reflecting on and applying such concepts as :

- |                          |                         |                            |
|--------------------------|-------------------------|----------------------------|
| * heritage value         | * ecological integrity  | * biological diversity     |
| * conservation           | * environmental justice | * wilderness values        |
| * productivity           | * procedural equity     | * intergenerational equity |
| * enterprise             | * initiative            | * economic viability       |
| * ethics and stewardship | * economic equity       | * creativity               |
| * consumption            | * efficiency            | * scarcity                 |
| * regional variations    | * resource              | * sustainability           |

(Queensland Government, 1998, p.3)

*Agenda 21* (the internationally agreed report of the United Nations Conference on Environment and Development or ‘Earth Summit’ which was held in Rio de Janeiro in June 1992) states the role of environmental education in relation to sustainability that:

“*Education* is critical for promoting *sustainable development* and improving the capacity of the people to address environ-goals in the light of contemporary thinking on the role of environmental education in promoting a *sustainable environment*.”

(Fien, 1995).

The above mentioned group calls this as ‘**education for sustainability**’, i.e. a *process* which :

- enables people to *understand the interdependence of all life* on this planet, and the repercussions that their actions and decisions may have, both now and in the future, on resources, on the global community as well as their local one, and on the total environment.

- increases *people's awareness* of the economic, political, social, cultural, technological and environmental forces which foster or impede *sustainable development*.
- develops *people's awareness, competence, attitudes and values*, enabling them to be effectively involved in *sustainable development* at local, national and international level, and helping them to work towards a more *equitable* and *sustainable future*. In particular, it enables people to integrate environmental and economic decision-making.
- affirms the *validity of the different approaches* contributed by environmental education, and development education as well as the need for the further development and integration of the concepts of *sustainability* in these, other related cross-disciplinary educational approaches, as well as in established disciplines.

(Sterling/EDET Group, 1992 in Fien, 1996).

There are five interrelated categories of objectives to foster the goals of ESD which may be achieved through the incorporation of effective strategies into teaching "Sustainable Development" in science curriculum at the educational settings. These include awareness, knowledge, attitudes, skills and participation (adapted from UNESCO-UNEP, 1978, p.3; and UNESCO and Australian Association for Environmental Education, 1993, p.34 in Fien, 1996).

### **Teaching "Sustainable Development" at school level: Various teaching strategies or approaches and worthwhile activities**

Various approaches and models are found to be suitable for investigative learning as well as for designing assessment tasks to address multiple core learning outcomes in STES education which are relevant to ESD. The following sections outline three basic areas whereby the teaching of science topics related to Sustainable Development could be adapted at school level.

#### **(I) Use of graphic organizers as thinking tools for effective science learning**

The "what, why, who, when and how" of graphic organizers

Graphic organizers are pictures or diagrams which represent a person's thinking in an organized manner, and have been referred to as 'mind tools' or 'thinking tools' which help organizing thoughts and assisting in generating ideas. Graphic organizers "engage student's visual intelligence, stretch students' thinking skills, promote active learning and their true value is in the mind seeing visual patterns as well as relationships, and deriving new insights from the patterning of the information" (Sharan, 1994). The following are some of the important factors identified to choose graphic organizers as effective strategies for ESD :

- promoting "Comprehension" abilities
- stimulating "Memory" techniques in the process of "Brain-based learning" :
- enhancing "Higher Order Thinking Skills" and
- stretching "Multiple Intelligence" capabilities :

(Kagan, 1998).

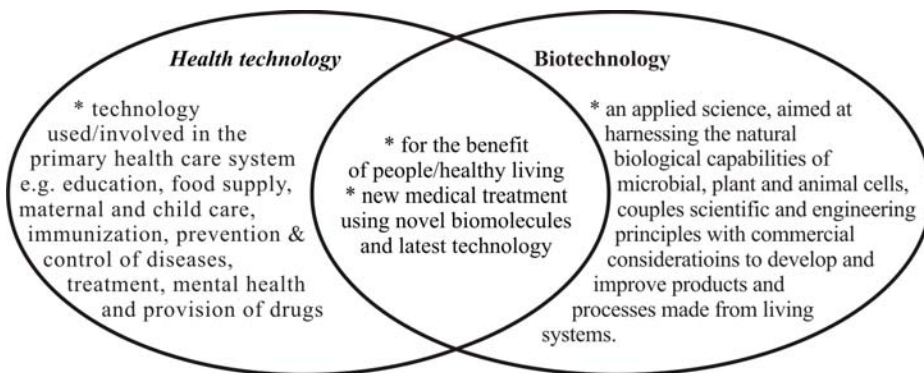
The use of graphic organizers should benefit all people in enhancing their thinking, and certainly teachers as well as students to organize information and ideas, generate many ideas, elaborate on ideas, represent abstract or implicit concepts in more concrete and explicit terms, relate new information to prior knowledge and assess thinking and learning.

In fact, each graphic organizer has a particular form and function and when effectively applied it can promote meaningful learning. Several graphic organizer designs have been developed and the following are a few which are identified to be suitable for science teaching and learning towards ESD. The ability to apply graphic organizers to specific situations is a powerful skill which will greatly enhance learning in STES education.

• **Venn diagram**

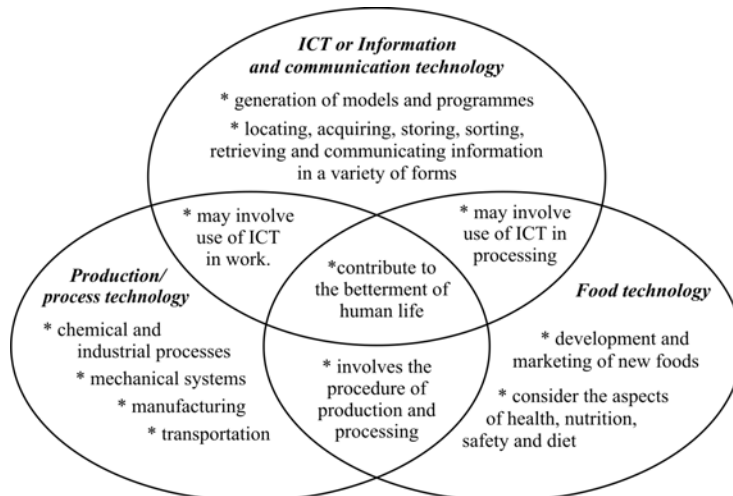
(a) *Basic venn diagram*

The basic Venn diagram is made up of two or more overlapping circles or ovals (as shown in figure) and can be used for comparing various dimensions or aspects of two objects, persons, ideas or concepts. This activity enables students to organize similarities and differences visually; similarities are listed in the intersection of the two circles/ovals, while differences are placed in the non overlapping sections.



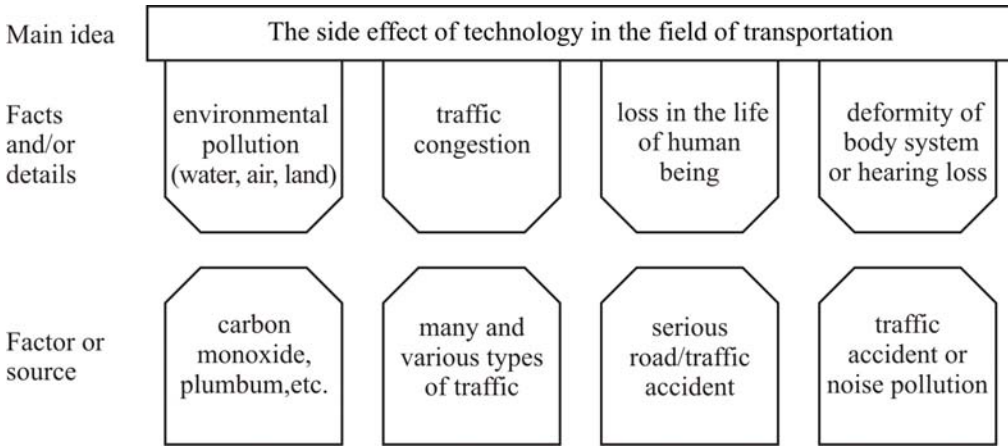
(b) *Expanded venn diagram*

The expanded Venn diagram has three overlapping circles/ovals (as shown in the following figure) and is used when comparing 3 items.



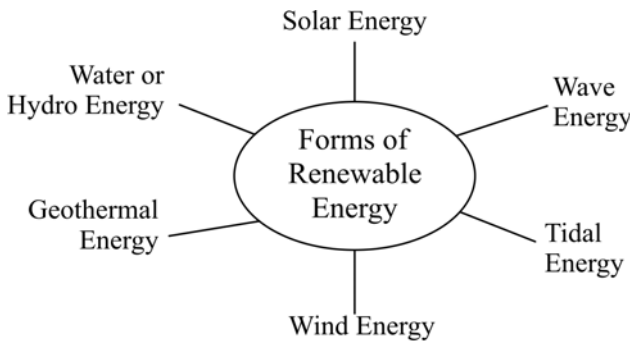
**Main Idea table**

This graphic organizer presents a main idea or generalization on the “table top” supported by the facts or details in the “legs” of the “table” (Refer the following figure). A variation of this is to add “feel” to the organizer which may be used to record sources of information.



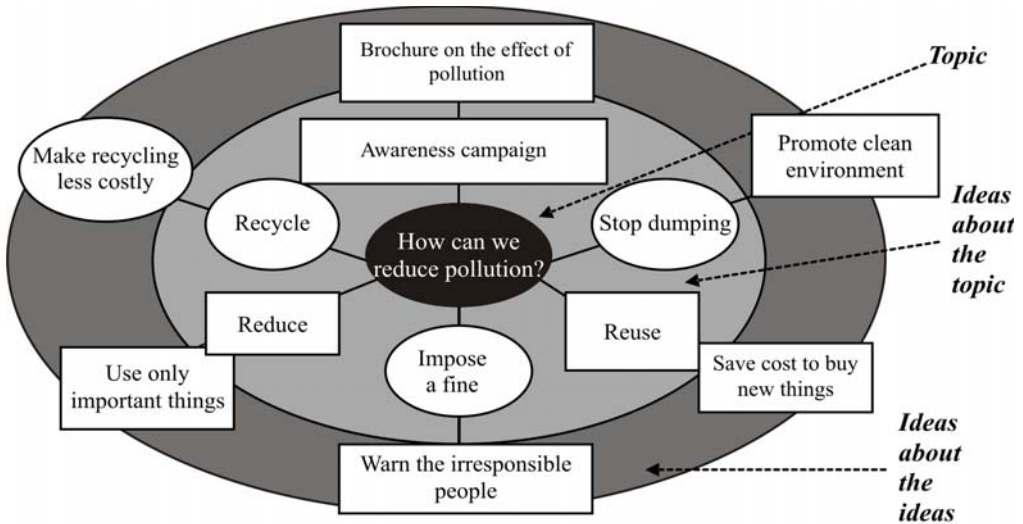
• **Attribute wheel**

The attribute wheel provides a visual representation of *analytical thinking*. The focus of the analysis (object, concept, system, etc.) is placed at the centre or hub of the wheel while the major characteristics or attributes are listed on the spokes.



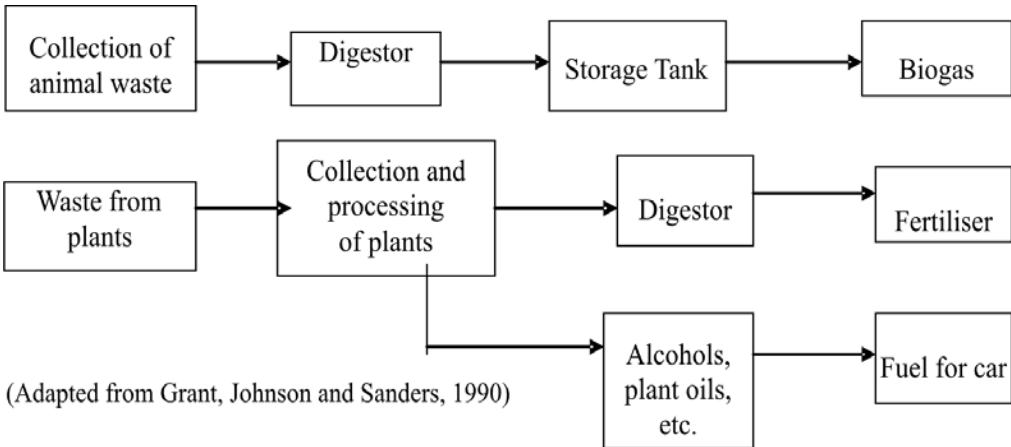
• **Web diagram**

The web features a central idea or topic located in the centre of the diagram. Related categories and supporting details branch out from the centre. The branches of the web contain related categories and specific details. The web can be used at the beginning of a lesson as a way to assess prior knowledge or may be used to develop creative thinking, as a way to generate ideas or brainstorming. It can also be used to summarize newly learned materials.



**• Sequence chain**

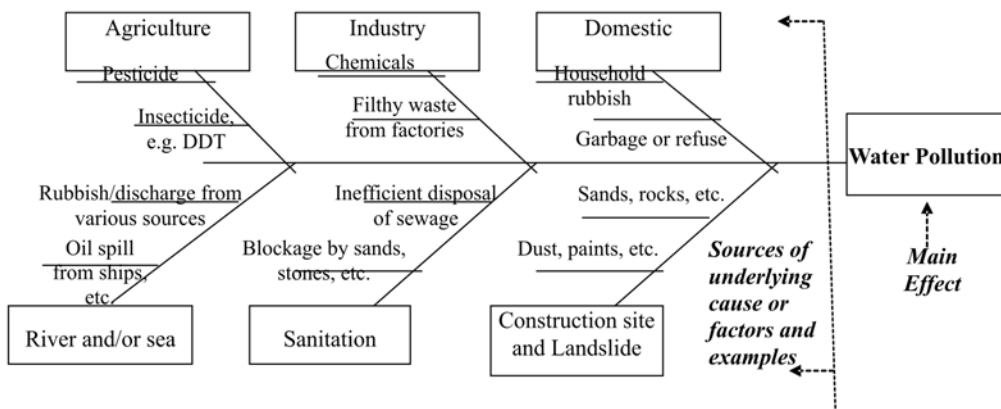
The sequence chain may be used to depict the sequential flow of information illustrating the ordered steps in a process (See the following diagram), such as the path of blood through the circulatory system or the steps in a chemical reaction. This is a good tool for organizing knowledge and is helpful in summarizing what has been learned (Sharan, 1994), especially related to ESD.



(Adapted from Grant, Johnson and Sanders, 1990)

**• Fishbone diagram**

The fishbone diagram is used to show the causal interaction of complex events or phenomena (e.g. prolonged drought, flooding, a nuclear explosion). The phenomenon or “effect” is placed in the “head” of the fish and the “causes” along the “bones” (see the following diagram). The fishbone diagram is most suitable for analysing “cause and effect” relationships in the environment. In this case the causes can be categorized as those originating from the environment, people, process, materials and equipment. These categories however, can be changed to suit the particular situation.



**(II) Integrating multiple intelligence with critical/creative thinking skills, contextual as well as other active teaching and learning approaches**

The teaching of critical and creative thinking skills with ethical concerns and moral values at various contexts are important aspects of ESD, as also outlined in the “Scope of development education for a better world” by Calder and Smith (1991). According to this proposal, the areas of knowledge and experience to be inculcated in all the curriculum areas, e.g. Science and Technology, Health Education, Mathematics, Environmental Studies, etc., should take into consideration the aspects of “knowledge and understanding, feelings and values, involvement and action, as well as skills and processes including inquiry, critical/decision making/problem solving, communication, social skills, etc.” (Calder and Smith, 1991, p.18).

The teaching of Sustainable Development at school level could include multiple intelligence and active learning strategies such as music, drama, role play, and/or incorporating other contextual learning approaches such as cooperative learning, project/problem/programme-based learning, etc. including the teaching of scientific investigative skills .

- Students could be encouraged to develop scientific investigative projects, the output of which could be displayed in the science fairs or science congresses, based on the investigation topics related to STES as well as issues or themes on Sustainable Development.
- The following steps are suggested as one teaching strategy for “investigation of environmental issues”, i.e. “Select the issue; Clarify the nature of the issue; Research and analyze the various viewpoints; Evaluate alternative viewpoints and their implications; and Investigate possible resolutions of or action to overcome the problem” (NSW Department of Education, 1989, p.30).
- The following are the processes involved in the action research for community problem-solving, i.e. “Identify problem, Investigate problem, Evaluate data, List possible actions, Predict outcomes, Select best action, and Evaluate action” (ibid., p.24).

### **(III) Use of Information and Communication Technology (ICT) incorporating other innovative strategies**

The integration of technology in science teaching that incorporates innovative strategies such as project-based learning (PBL) has gained increased attention in recent years and are still considered to be prominent initiatives for the promotion of Science and Technology Education (STE) and ESD. Research shows that technology can contribute to students finding their projects to be interesting and valuable. Projects in the sciences can build from students' questions, and when well-guided by mentors, provide motivating and effective contexts for the acquisitions of research skills and scientific understanding. Whereas, technology can enhance challenge, variety and choice by providing multiple levels of tasks to match students' knowledge and proficiency, access to numerous sources of information that allow breadth in project questions (Fogarty, 1998). For example, Science Across the World (SAW) international flagship programme provides a forum generally suitable for students mainly from the age group of 12 to 17 years to exchange facts and opinions with young people in other countries, based on the level of knowledge and skills required in the topics which are related to the current issues in STES education (Refer : <http://www.scienceacross.org>).

Various web-based learning programmes were also developed to facilitate the teaching of "Sustainable Development" in Environmental Education. The following are two examples of web-based assignments for Environmental Education by two schools in Australia :

1. Dalby South State School, a rural primary school located about 80kms west of Toowoomba, Australia. Refer : <http://www.usq.edu.au/users/maroulis/AAUT/www.connect.usq.edu.au/students/d8842394/index.html> or <http://www.usq.edu.au/users/maroulis/aaut/www.connect.usq.edu.au/students/d8842394/enviro1..html>

Among the features in the above website are the introduction to the "Site", "Plan", "Group Dynamics" and "Educational Opportunities".

2. Toowoomba East State School, Australia. Refer: <http://www.usq.edu.au/users/albion/enviro/index.html> or <http://www.usq.edu.au/users/albion/enviro/4.htm>

Among the features in the above website are the introduction to the "Existing School Grounds", "Our Ideas" for EE, "Activities such as Ecology (including e.g. Herb Garden, Adopt-A-Tree/Hug-A-Tree, Nature Trail), Waste Management, Global Warming" and "Group Dynamics".

### **Conclusion**

As the world move toward sustainable development, various attempts have been made at the policy level in many countries to emphasize the need to teach values in STES education in the recent years. Teachers play a critical role to bring about behavioural and attitudinal changes in their students who will be the future citizens of the world. As such, their exposure to the concept of sustainable development as well as the trainings given to enhance their knowledge, skills and awareness are important for their continuing professional development (CPD). In fact, "teacher training is a key factor in the

development of Environmental Education (EE)”, as resolved by the ‘Tbilisi Plus 10’ International Congress on Environmental Education and Training in Moscow in 1987, as illustrated below,

*“...The application of new EE programmes and proper use of teaching materials depends on suitably-trained personnel, as regards both the content and the methods specific to this form of education. Teachers well trained in the contents, methods and process of EE development can also play a crucial role in spreading the impact of EE at the national level...”*

(UNESCO-UNEP, 1988, p.12 in Fien, 1996)

This article only outlines some of the strategies that could be used in science teaching applying the principles of sustainable development. It is hoped that with adequate training and guidelines given by teacher educators as well as policy makers to introduce more innovative and effective teaching strategies, the ESD will be achieved at school level to ensure a sustainable level of population and fulfil the various principles outlined for sustainable development according to the Brundtland Commission (Fien, 1996).

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<http://www.junebox.com/frey/> and <http://www.junebox.com/lessons/science.html> (*Frey Scientific*)

<http://www.kcl.ac.uk/depsta/education/publications/be2000.pdf> (*Beyond 2000 : Science ed. for the future*)

<http://www.qscq.qld.edu.au> (*Queensland School Curriculum Council*)

<http://www.scienceacross.org> ("*Science Across the World*" *International Programme*)

<http://www.uq.net.au/qscq/sose> (*Queensland Government*) Email : [qscqinquiries@qed.qld.gov.au](mailto:qscqinquiries@qed.qld.gov.au)

<http://www.usq.edu.au/material/80218/98s2/menu.htm> (*Environmental Education*)

[http://www.usq.edu.au/users/maroulis/full\\_confpaper.htm](http://www.usq.edu.au/users/maroulis/full_confpaper.htm) (*AACE*)