Overcoming the Challenges of Sustainable Development through Science and Technology Education

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Abstract

It is now generally, recognized that the world's present approach to growth is built upon foundations that are not sustainable because of resource depletion and the negative impacts of pollution and greenhouse gas emissions on the relationship between people and the planet. Climate change in particular is having an impact not only on people's lives and livelihoods, but on the increasingly urgent search for "green growth," that is to say for alternative economic strategies that meet the needs of the present without compromising the opportunities of future generations. It is also widely recognized that new technologies, particularly ICTs, are having a major impact on economic and social relationships among individuals, communities and nations. High-speed telecommunications have been a major driving force of globalization in capital, labour and product markets. Mobile telephones have, for the first time, made immediate communications at a distance available to the majority of individuals worldwide.This paper therefore takes a look at the issues of Sustainable development, Science education, Sustainable Development issues for Education, How Science and Technology Education can relate to Sustainable Development. A comparison of similarities and differences in philosophical emphases between 'Science through Education' and the alternative 'Education through Science' was also given. Finally, conclusion were drawn and recommendations given.

Keywords: *Sustainable Development, Science Education, Science, Technology Education, and Scientific Literacy*

Introduction

In the late 1980s and early 1990s, the World Commission on Environment and Development and the subsequent UN Summit, held in Rio de Janeiro and popularly known as the Earth Summit, focused the world's attention on sustainable development (Souter, 2010). They recognized that growth that depended on short-term depletion of natural resources could not lead to long-term prosperity or welfare. They defined sustainable development as "development that meets the needs of the present, without compromising the ability of future generations to meet their own needs." (WCED 1987, part 1, sec. 2, para. 1).

The importance of sustainability has been increasingly recognized in development policymaking since the Earth Summit took place. Although it is concerned with economic and social as well as ecological sustainability, environmental issues—and particularly climate change—have continued to sharpen this emphasis.

Comparable attention to Information and Communication Technologies (ICTs) in development arose in the late 1990s and early years of the present century, and also focused around a UN Summit; in this case, the two-part World Summit on the Information Society held in 2003 and 2005 (Souter, 2010). Dramatic changes in the technology and economics of communications enabled

rapid and far-reaching expansion of communications access and the range of communications services, including the advent and spread of the Internet.

At the least, these changes in communications have had profound effects on economic and social structures and on individual behaviour. For many in the field, these—and potential changes yet to come—represent the transition to a post industrial Information Society, in which knowledge and networks play a more prominent role than capital and hierarchy.

It is now generally—if not yet universally— recognized that the world's present approach to growth is built upon foundations that are not sustainable because of resource depletion and the negative impacts of pollution and greenhouse gas emissions on the relationship between people and the planet. Climate change in particular is having an impact not only on people's lives and livelihoods, but on the increasingly urgent search for "green growth," that is to say for alternative economic strategies that meet the needs of the present without compromising the opportunities of future generations.

It is also widely recognized that new technologies, particularly ICTs, are having a major impact on economic and social relationships among individuals, communities and nations. High-speed telecommunications have been a major driving force of globalization in capital, labour and product markets. Mobile telephones have, for the first time, made immediate communications at a distance available to the majority of individuals worldwide.

The Internet has transformed the availability of information and disrupted traditional social and economic structures, from intellectual property and trade in goods and services to privacy, political debate and social mores.

Defining Sustainable Development

The World Commission on Environment and Development - the Brundtland Commission- defines sustainable development in its 1987 report as follows:

> *Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: in the concept of 'needs,' in particular the essential needs of the world's poor, to which overriding priority should be given; and n the idea of limitations imposed by the state of technology and social organization, on the environment's ability to meet present and future needs. (WCED 1987, part 1, section 2, para. 1).*

Although the definition of sustainable development emerged from an international enquiry into the relationship between environment and development, it is not concerned primarily with the environment but with the sustainability of the overall developmental context. This usually comprises three main elements:

1. **Economic development** – reducing and seeking to eradicate income poverty, achieving higher levels of prosperity and enabling continued gains in economic welfare;
2. **Social development** – reducing and seeking to eradicate other dimensions of poverty, improving the quality of education, health, housing and other aspects of the welfare of individuals and communities, and enhancing the quality of social interaction, engagement and empowerment;
3. **Environmental protection** – reducing pollution and other negative impacts on the environment, mitigating the effects of industrialization and human activity, and seeking to

achieve sustainable use of resources in the interest of future generations (WSSD, 2002 a, ch. 1, para.2).

This relationship is sometimes illustrated either as pillars or through a Venn diagram as here: three pillars or circles of "economic development, social development and environmental protection" as three "interdependent and mutually reinforcing pillars" of sustainable development (United Nations General Assembly, 2005, para. 48).

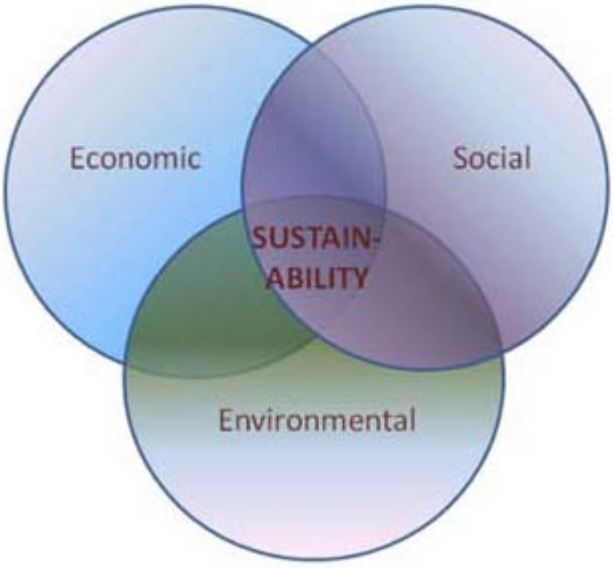

Diagram adapted from Barbier, E. (1987).

Development, in this context, is not a matter merely for developing countries, as the term is sometimes used. It is about development at all levels, from the family, through local communities, regions and nations, to the planet as a whole. Sustainability needs to be a priority in all countries—post-industrial and industrial as well as developing countries—and in the international system that links them.

Some analysts of sustainability add one or two additional aspects of development to this tripartite framework. These are:

1. **Cultural diversity** – the continuance of diverse human cultures from past to future within a context of the globalization of communications, economy and society and the more intensive intercultural interactions that result; and
2. **Governance**– the institutional mechanisms, rules and norms that encompass decision making and behaviour by governments, businesses and citizens, the interactions among these stakeholders and among different policy domains.

The sustainability of development results not from any individual part of this framework—from economic growth, for example—but from the framework as a whole: from the cumulative impact of all three (or five) components, from the interactions among them and from the system-wide outcomes that result from these.

Sustainable development, in other words, looks at development holistically, rather than from one dimension of the development ecosystem. This is often misunderstood.

The Brundtland Commission (1987) recommended seven critical actions needed to ensure good quality of life for people around the world (WCED, 1987, ch. 2, para. 28):

i. Revive growth;
ii. Change the quality of growth;
iii. Meet essential needs and aspirations for jobs, food, energy, water and sanitation;
iv. Ensure a sustainable level of population;
v. Conserve and enhance the resource base;
vi. Reorient technology and manage risk; and
vii. Include and combine environment and economic considerations in decision making.

These factors place a demand on us to:

i. Produce differently by increasing efficiency and reducing material used in production. The goal is to quadruple resource productivity so that wealth is doubled, and resource use is halved.
ii. Consume differently by developing policies that promote consumption patterns that reduce the ecological footprint of development while meeting the needs of all people so they enjoy a good quality of life.
iii. Organize differently by engaging all stakeholders and improving public participation in all steps of planning, implementation and evaluation of policies and actions; reducing global subsidies and applying some of these to sustainable development.

Accordingly to the World Bank (see World Bank, 2004; 2003; 2003a), development in the 21st century is a multi-dimensional concept which combines five perspectives, all of which are key to making development sustainable:

- ***Financial capital***: sound macroeconomic planning and prudent fiscal management.
- ***Physical capital***: infrastructure assets, such as buildings, machines, roads, power, plants, and ports.
- ***Human capital***: good health and education to maintain labour markets.
- ***Social capital***: people's skills and abilities as well as the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions.
- ***Natural capital***: natural resources, both commercial and non-commercial, and ecological services which provide the basic requirements, including food, water, energy, fibers, waste assimilation, climate stabilisation, and other life-support services.

Science Education

Science is the study of nature and the way things in the world are made and act (Olubela, 2009 in Adesola, 2010). Science is the study of knowledge comprising facts and principles guiding the understanding of things around us. Science is based on the acquisition of knowledge that is based on examining, testing and proving of facts. Busari (2009, in Adesola, 2010) also stated that, science is used to connote the distinctive methods by means of which knowledge is acquired, refined and certified. He stated further that, it is a body of knowledge (though organized) resulting from these methods when put into operation. Hence, science is both a product and process of investigation and research.

The process of science as used above is concerned with the scientific activities or methods by means of which information is gathered, analyzed, synthesized and disseminated. These activities according to Busari and Sodipo (2000) include observation, classification, measurement, collection of data, interpretation of data and experimentation among others. Scientific product on the other hand refers to the library of knowledge in the form of facts, concepts, principles, theories and laws.

Education has also been defined in various ways by several authors. Taiwo (1987) in Oduolowu (1999) defined education as the training of the young with a view to helping their growing up and developing into adults who can fend fro themselves, live in a society and be service to that society. Bamisaye (1987) in Oduolowo (1999) also observed that education is expected to affect the social behavior of either the educated person or the person being educated. Such social behavior ranges from avoidance of social crimes like stealing, rape, abusive language and unruly behavior of any form.

From the above definitions, aesthetic and ethical considerations are relevant to the concept of education. It also involves acquisition of knowledge, abilities and skills which would enable the individual to be more functional in his environment and society at large. To many parents and governments, education of the child means, the learning which takes place in the schools and animates in the acquisition of certificates.

What are the major Sustainable Development issues for Education?

From an education perspective, developing sustainable development can be viewed as (Ospina, 2000):

1. Placing a system of values and ethics at the centre of society's concerns;
2. Encouraging a meeting of disciplines, a linking of knowledge and of expertise, and to render our understanding more integrated and contextualized and so, in turn, to open up new horizons for justice and equality (equity);
3 Encouraging lifelong learning, starting at the beginning of life and grounded in life – one based on a passion for a radical transformation of society and a change in the moral character of society;
4 Advancing new conceptions rooted both in traditional scientific rationality and in popular beliefs and consciousness, drawing on these as a source of human understanding and a pointer to collective wisdom;
5 Encouraging the refinements of locally based processes of change and of integral community advancement, one not marked by a passive receptivity to or a mindless repetition of homogeneous development models;
6 Ensuring priority is given to fundamental critical questions, to the method as a means of approaching tangible realities, by promoting dialogue among the sectors of society and a real interdisciplinary approach;.
7 Elevating the importance of social subjectivity and of the qualitative dimension of social life;
8 Encouraging new alliances between the State and civil society in promoting citizens' emancipation mediated by the practice of democratic principles while fully acknowledging the compexities inherent to every human reality.

For the above to be put into place, it is suggested that education needs to be viewed as a means to (Opsina, 2000):

i. Promote a culture of citizenship and give value to social actors (such as non-governmental organizations and other sub-groups);
ii. Mobilize society in a concerted effort so as to eliminate poverty and all forms of violence and injustice that jeopardize the future and the maintenance of a good quality of life;
iii. Valorize aesthetics, the creative use of the imagination, an openness to risk and flexibility and a willingness to explore new options;

iv. Assert the importance of local communities and their ties to the entire Earth and indeed with the universal; identify and pursue new human projects in the context of a planetary consciousness and a personal and communal awareness of global responsibility;
v. Engender new hopes and ways of channeling the valuable energies and resources of entire nations; seek understanding, to anticipate, to imagine and to contextualize;
vi. Reach a stage in which the possibility of change and the real desire for change are accompanied by a concerted, active participation in change, at the appropriate time, in favour of a sustainable future for all;
vii. Instill in the minds of all people a conviction of the values of peace in such a way as to promote the creation of new lifestyles and living patterns;
viii. Develop to the maximum, the potential of all, throughout their lives, so that they can achieve self-fulfillment and full self-expression with the collective achievement of a viable future; effect change in value systems, behavior patterns and lifestyles necessary to achieve sustainable development, and ultimately democracy, security and peace;
ix. Disseminate the knowledge and skills necessary to foster sustainable production and consumption patterns and to improve the management of natural resources, agriculture, energy and industrial production;
x. Ensure an informed populace, prepared to support changes in other sectors conducive to sustainability.

How Science and Technology Education relate to Sustainable Development?

Science, over the last 100 years, has slowly been given a place in the curriculum. Yet its original purpose (to prepare students for science studies at University (Fensham, 2008) has tended to remain the predominant determinant of the content and hence the focus of teaching and learning.

The content for learning still carries the strong conceptual tone that characterized the scientific preparation of an elite group, as if they were the sole concern and purpose of school science. Getting the balance right between the purposes of enthusing enough students to go on to scientific and technological careers and giving all students an interest in, and enough knowledge of science and technology so as to appreciate the importance of science and technology in society, is perhaps the major science education issue facing all countries today. This suggests that the aims for school science curricula need to be examined, especially with respect to social relevance and hence sustainable development. Equipping young persons to participate in the big socio-scientific issues of today (for example, food scarcity, poverty alleviation, HIV/AIDS/ peace building, global warming, cloning, embryonic stem cell use, toxic waste disposal, sustainable development, etc.) makes good sense in the compulsory years of education.

Scientific Literacy

A common expression in many curricula today indicates that the purpose of science education in schools is to enhance ***scientific literac****y*. The precise meaning of scientific literacy is unclear and there is much controversy over whether it refers to learning science content, as the intended focus of science education. The ICASE definition of scientific and technological literacy clearly relates to the issues of sustainable development above and beyond specific content. This definition put forward in 1997 (Holbrook and Rannikmae) states: *"developing the ability to creatively utilise sound science knowledge in everyday life, or in a career, to solve problems, make decisions and hence improve the quality of life."* This view of scientific literacy is still very valid today.

A comparison of similarities and differences in philosophical emphases between 'Science through Education' and the alternative 'Education through Science' (Holbrook & Rannikmae, 2007)

	Science through Education	**Education through Science**
1	Learn fundamental science knowledge, concepts, theories and laws.	Learn the science knowledge and concepts important for understanding and handling socio-scientific issues within society.
2	Undertake the processes of science through inquiry learning as part of the development of learning to be a scientist.	Undertake investigatory scientific problem solving to better understand the science background related to socio-scientific issues within society.
3	Gain an appreciation of the nature of science from a scientist's point of view.	Gain an appreciation of the nature of science from a societal point of view.
4	Undertake practical work and appreciate the work of scientists.	Develop personal skills related to creativity, initiative, safe working, etc.
5	Develop positive attitudes towards science and scientists.	Develop positive attitudes towards science as a major factor in the development of society and scientific endeavours.
6	Acquire communicative skills related to oral, written and symbolic/tabular/ graphical formats as part of systematic science learning.	Acquire communicative skills related to oral, written and symbolic/tabular/ graphical formats to better express scientific ideas in a social context
7	Undertake decision making in tackling scientific issues.	Undertake socio-scientific decision making related to issues arising from the society.
8	Apply the uses of science to society and appreciate ethical issues faced by scientists.	Develop social values related to becoming a responsible citizen and undertaking science-related careers.

Conclusion

The acquisition of "big" ideas in science is relegated to building a concept of the nature of science and/or the promoting of personal intellectual thinking needed to promote sustainable development. This does not mean knowledge is excluded from the teaching of science, but it is recognition that useful basic knowledge is tentative, liable to regional variations and best included on a need-to-know basis. The key driving force for EtS is the need for students to acquire social skills, supported by personal skills, thus enabling students (and later as adults – Roth and Lee, 2004) to draw on their scientific literacy to play a responsible role within society. Ensuring students are able to function within the world of work at a skill or responsibility level, commiserate with the students' aptitude and ability; Possessing a conceptual background, or skills of learning so as to

learn to cope with a need to - have, relevant public understanding of science and technology in a changing society.

Recommendations

After careful analysis of the review work in sustainable development and science education, it is therefore recommended that science literacy should trend thus towards:

(a) Inclusion of issue-based or context–based teaching as a major thrust to 'set up' the scientific problem to be investigated.
(b) There is the need to go beyond scientific problem solving to also encompass socio-scientific decision making (related to responsible citizenry).
(c) Recognition that scientific literacy relates primarily to enabling citizens to effectively participate in the real world and is thus a social rather than solely an individual consideration.

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