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Improving Resources for Science and Technology Delivery in the Primary Schools for Sustainable Development

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Abstract
This is a theoretical paper centered on resources for teaching science and technology in the primary schools. It will provide guidance to primary school teachers looking for ways to find current information on science resources, programs, materials and methods of teaching and learning of science and technology for developing the potentials of children in science and technology. Important concepts such as Science, Technology, Sustainable Development, Sustainability Education, and Science Resources were defined. Teaching techniques and the use of technology in teaching STM at primary school level were also discussed. In conclusion, children possess God-given potentials that just need to be directed, channeled and manipulated in order to make them function in the society. Today, emphasis on STM education has been on activity-based teaching methods that will involve the learner in hands-on and minds-on activities for the acquisition and application of scientific and empirical knowledge and skills. This can only be achieved if resources are adequately used and teachers are skilled and competent enough to use them.
Keywords: Science, Technology, Sustainable Development**,** Sustainability Education, Science Resources.

Introduction

If education is seen as the key to creating positive social and environmental change, people of all ages, including children need to assume responsibility for their actions. In other words the entry point of intervention in the delivery of a suitable science education for sustainable development is the primary level by exploiting the potentials of the children. Enhanced *science teaching* at both the primary and secondary levels is central to *scientific* and technological development of the society. The problem being addressed in this theoretical paper is embedded in the fact that the gap between" content knowledge" contained in the syllabus and the text books and" learnable knowledge" which is the amount of content the pupils were able to absorb during the teaching and learning process continues to increase. Not only that, throughout the authors' years

of interactions with pre-service, in-service teachers and students both at the primary and post primary level, pupils who are slow learners were lumped up with average and brilliant students in regular classes. The advocacy is in favor of developing a school policy for sourcing primary science resources support for teaching and learning across the school levels and skillful use of science resources by teachers.

What are Resources?

Teaching and learning resources are those resources that facilitate the achievement of the goals and objectives of education. These include human and non-human or material resources. Human resources are the subject teachers, pupils, parents, community members, other professionals, donor agencies like non-governmental organizations (NGO), UNICEF, UNESCO, etc. (NTI, 2010).

The non-human or material resources include physical facilities and instructional materials. World Bank (2011) has indicated the potentials of Information and Communication Technology (ICT) to improve instruction.

Unfortunately, there has been shortage of instructional resources for STM delivery in schools (Olatunde 2010). This is confirmed by Soyibo, Ajayi and Ajayi in Adebayo (2011) who submitted that scientific instructional materials, equipment and laboratory facilities are grossly inadequate in schools. Most of teachers are not very knowledgeable, skillful and competent enough on the use and improvisation of materials. They teach mathematics and science subjects when they did not specialize in them. It is therefore necessary to improve STM teacher skills and competence in the use of resource for STM delivery.

In a workshop organized for Primary school teachers by United Nations Development Program (UNDP)/MDG at Ikaramu, Akoko for Primary School teachers, Duyilemi (2009) in her paper, advised teachers to use the following for successful STM delivery.

- Science and Technology Corner: A corner in the classroom containing locally made resources for science and technology teaching.
- Science and technology resource centre: An established resource centre for basic science and technology teaching usually managed by the Ministry of Education.
- Improvisation: Use of locally available materials to devise instructional materials in place of standard ones or substitute for original.
- Information and Communication Technology (ICT)

In a study carried out by Ofoegbu (2012) on Resources for Teaching Basic Science and Technology in Nigerian Primary Schools in Enugu State, it was found that teachers sparingly involve parents, community members, NGO in teaching basic science and technology, the findings also indicate that teachers only use textbooks and chalkboard always. They occasionally use charts, flat pictures, posters, cartoons, models, science and technology corner, improvisation and flannel board. However, they use science and technology sparingly. It was also found that none of the ICT resources investigated was always or occasionally used by teachers in teaching basic science

and technology. The researchers are of the view that, in order to develop the potentials inherent in Primary School children, they must be exposed to activities that will involve the use of all their senses for meaningful learning to take place in STM.

What is Sustainable Development?

The term "sustainable development" becomes prominent after the Rio Earth Summit in 1992 which prioritized global environmental discussions and improved upon the initial framework introduced at the United Nations Conference on the Human Environment, Stockholm in 1972. The resulting Rio Declaration on Environment and Development, however, advocated the role of education in preventing ecological degradation (Cleveland & Kubiszewski, 2007).

In order to implement sustainable development, it became necessary to develop the ideas further in terms of defining what sustainable means and the relevance of development and distinguishing it from environmental education. For this report, *sustainability is understood as the end state and sustainable development is understood as the process of getting there.*

Environmentalists and researchers recognized, though, that development patterns were harming the environment and that social problems were emerging. In an attempt to address these imbalances, a variety of models and frameworks were created to identify priority areas in sustainable development and ways to achieve progress by identifying economic, social and environmental goals. These three elements compose the three pillars of sustainable development. Each one of the three pillars carries similar importance in creating and maintaining stability and balance. Sustainable development emphasizes the active participations of local and community citizens. Education for sustainability addresses the economic, social, and environmental issues of the world. Sustainability education in general, provides young people and citizens with the knowledge, skills, and attitudes that will enable them to meet their own needs without compromising the ability of future generations to meet their own. To achieve this, teaching methods that fulfill the special demands of the sustainable development education were employed.

The Rationale for Education for A Sustainable Future

The following are the bases for the advocacy for education, curriculum change and design, as well as interdisciplinary course syllabi etc that will promote sustainability

(i) Learners and their teachers will have basic understanding of sustainable development;
(ii) This new programme will help in the understanding of the range of social, economic, and environmental issues facing the world today; the interrelationships among these different types of issues; and the ways that education is key to the empowerment of people working for a sustainable future;
(iii) Creating awareness about the various strategies for the education community to reorient education toward the broader process of building a sustainable future.

Definition of Science

The word science comes from the Latin "scientia," meaning knowledge. According to Webster's New Collegiate Dictionary, the definition of science is knowledge attained through study or practice, or knowledge covering general truths of the operation of general laws, especially, as obtained and tested through scientific method using the physical world. Science refers to a system of acquiring knowledge. This system uses observation and experimentation to describe and explain natural phenomena. The term science also refers to the organized body of knowledge people have gained using that system. Less formally, the word science often describes any systematic field of study or the knowledge gained from it. Science Made Simple, Inc (2006) opined that it is important to study science because it is part of almost every aspect of our lives. Although we rarely think about it, science makes extraordinary things possible. With the pace that the world keeps and the speed with which technology advances, an understanding of science is a crucial part of a rounded education and this should start from the primary school. Moreover, Nigeria as a country needs more scientists and much more people skilled in science and technology in order to compete in the global arena. It is, however, becoming increasingly difficult to attract young people to science careers. There is also a clear gender imbalance in science, engineering and technology. The necessity therefore is great to commit resources in order to enhance science teaching for sustainable development. Enhanced science teaching at both the primary and secondary levels is central to scientific and technological capacity building and to a better public understanding of sustainable development issues. At the tertiary level, the target should be to increase the percentage of university level students enrolled in science, mathematics and engineering. Current enrollments are decreasing in most developed and developing countries alike. The three core components which are critical in enhancing capacity are skilled individuals, efficient institutions and active networks.

What is Technology?

Throughout the twentieth century the uses of the term have increased to the point where it now encompasses a number of big ideas depicting various nature of technology. According to the UK Technology Education Centre

(i) **Technology as Objects**

The physical devices of technical performance e.g. Tools, machines, instruments, weapons, appliances

(ii)**Technology as Knowledge**

The know-how behind technological innovation

(iii)**Technology as Activities**

What people do - their skills, methods, procedures and routines.

(**iv)Technology as a Process**

Begins with a need and ends with a solution

(iv) Technology as a Socio technical System

The manufacture and use of objects involving people and other objects in combination

UBEC/SUBEB training of Teachers and Education Managers, 2011 version, defined technology as a process of practically applying scientific knowledge and using the resources of matter, energy and natural phenomenon to solve human problems and making life easier.

The Impact of Science and Technology on Sustainable Development

Science and Technology is essential for sustainable development. This is because humanity has been in contact with the challenges of sustainable development and achieving it requires that the fundamental issues be addressed immediately at local, regional and global levels. Scientific knowledge and appropriate technologies are central to resolving the economic, social and environmental problems that make current development paths unsustainable. Bridging the development gap between the developed and developing countries, and alleviating poverty to provide a more equitable and sustainable future for all, requires novel integrated approaches that fully incorporate existing and new scientific knowledge. The Scientific and Technological community can make a leading contribution to tackling major problems such as fighting against disease, population growth and urbanization, the digital/information divide, coping with climate changes, confronting the water crisis, defending the soil, preserving the forests, fisheries, biodiversity as well as building a new ethic of global stewardship. Good science is essential for good governance.

Whatever the cultural, geographical, socio-economic and environmental setting; a strong partnership between the STM community and other members of the civil society, the private sector and governments is a fundamental prerequisite for sustainable development. Interdisciplinary research that addresses the social, economic, and environmental pillars of sustainable development needs to be encouraged. Nigeria should focus on developing new clean technologies, and supporting sustainable production systems and consumption patterns. Improvisation, (easily and economically constructed teaching aid from readily available materials by local craftspeople), have a central role in the alleviation of poverty in the developing world. Oluwatelure (1999) Preparing improvised equipments for use in science classrooms should involve collaboration between learners, teachers parents as well as local craftsmen. If this is done in good faith, it is expected to lead naturally to the emergence local technology. There has been emphasis by stakeholders for the adoption of appropriate local, culturally adapted and low-cost technologies in developing countries (Pearce, 2007)

Teaching Sustainable Development in the Primary Schools

There is advocacy by the Association for Science Education United Kingdom for the teaching of sustainable development in primary schools. The materials provided by them are expected to help the teachers understand and teach sustainable development. The package also includes eight in-depth case studies on different themes, including energy, rain forests, water, waste and recycling. It contained key ideas for teachers about the topics, learning objectives, ways of ensuring a sustainable development focus, full details of the lesson sequences together with descriptions of pupil activities and resources needed for the teachers' reflections on the work. Under the influence of traditional teaching mode, the teaching aiming at sustainable development concept or knowledge system easily becomes formalistic, theoretic knowledge

infusion and concept deduction, but in the teaching method in which the teaching party and the studying party directly participate, concept of sustainable development is flexible and innovational; the characters indicate the direction for the practice and the enhancement of the teaching material s. Difficult questions are discussed and learners' practical application ability is cultivated. Dialog mode, discussion method, and heuristic mode of teaching is emphasized to cultivate students' independent thinking ability, suspicious and critical spirit.

The Role of Resource Support in Teaching and Learning Science are

(i) development of subject knowledge e.g. electricity, forces
(ii) to development of thinking ability (scientific enquiry)
(iii) to create awareness about the use of outdoor in science
(iv) to encourage creativity in science;
(v) to stimulate application of science;
(vi) to create awareness about the links between science and other areas of the curriculum e.g. technology.

Teaching Strategies

The fundamental importance of teaching strategies is to make it easier to implement a variety of teaching methods and techniques. Oluwatelure (2010) there are a variety of teaching strategies to help students take more responsibility for their own learning and enhance the process of teaching for effective learning. It is important to create learning environments that are more interactive, to integrate technology where applicable into the learning experience, and to use collaborative learning strategies when appropriate.

Lecture

The lecture method can be very effective when used in conjunction with active learning and teaching strategies. The traditional lecture has many advantages, particularly in the large classroom, and can be effective in meeting instructional goals. Advances in technology, and the increasing ease of application can turn the lecture into a methodology which touches on learning diverse modalities and increases content relevancy.

Active Learning

Myers and Jones (1993) define active learning as learning environments that allow students to talk and listen, read, write, and reflect as they approach course content through problem-solving exercises, informal small groups, simulations, case studies, role playing, and other activities. These require students to apply what they are learning, and touches on the highest levels of learning taxonomy.

Critical Thinking

Lipman (1988) defines critical thinking as skillful, responsible thinking that facilitates good judgment because it relies upon criteria, is self-correcting, and is sensitive to context. A list of applicable skills includes focusing, information gathering, referencing, organizing, analyzing, integrating, and evaluation.

Discussion

There are a variety of ways to stimulate discussion. A large part of the process is the creation of a non-threatening, interactive learning environment that allows for the free exchange of ideas. An important element is the use of inquiry questioning to stimulate discussion and bring the forum to the highest levels. Discussion is central to active student learning in many courses. Nevertheless, facilitating a good discussion remains a challenge, even for experienced instructors.

Cooperative Learning

Cooperative learning is a systematic pedagogical strategy that encourages small groups of students to work together for the achievement of a common goal. This learning strategy stresses the importance of teacher and student involvement in the learning process.

Writing

The basic principle underlying these initiatives is that writing is more than a technical skill to be acquired in a first-year course but is, in fact, a mode of learning that can enhance students' understanding of the content of the disciplines. This strategy includes writing across the curriculum, critical thinking, technology and computers, note taking, and personal expression. There are a variety of goals for incorporating writing within a course. The conventional goal is to demonstrate learning where clarity is the primary requirement. There is also writing for learning, fostering involvement in course material and promoting learning.

Simulations

This reduces complexity and highlight salient aspects. Simulations give concrete ways to teach abstract concepts. Providing concrete examples for abstract concepts is especially important for children and adolescents, many of whom are still in the concrete stages of cognitive development

Uses of Teaching Methods in teaching for Sustainable Development

Classroom Discussions Method

Classroom discussion is student-centered. It stimulates pupils to analyze and think critically and promote participatory learning. When properly planned it may involve verbal exchanges among group members. Discussions can take a variety of forms, e.g. Large-group discussion involving the whole class; while small-group discussion may involve just two to six pupils. Characteristically, discussion method can be teacher-led, pupil-led, or interactive. Discussion method do requires settings that are governed by rules such as: one person speaks at a time, while the others listen. Teachers can use discussion method to assess pupils' knowledge and application of the three spheres of sustainable development viz - *environment, society, and economy*. For instance recycling aluminum is good for the environment because it conserves energy; recycling is good for the economy as it gives opportunity for people to be employed; also, recycling is good for society that government does not have to spend as much on garbage collection and disposal and can therefore allocate the money for other priorities and needs, e.g. education, health etc. (NAAEE. 2010)

Storytelling Method

This method is very appropriate for teaching in the primary schools. Telling stories to convey and illustrate sustainability ideas is an engaging form of teaching. Stories can be taken from current events, history, television programmes, literature, drama, and personal experience. Story telling also draws on the oral traditions of indigenous societies and folk art. Storytelling has been practiced for generations as a means of entertainment, education or cultural preservation and to instill moral values among younger generations. Storytelling is an effective pedagogy as the values reflected in traditional stories often contain the wisdom of the elders or stem from creation stories, which helps to impart respect for cultural heritage as well as the environment.

Storytelling makes ideas, theories, and concepts learned from textbooks come alive. Storytelling adds a human element to otherwise dry information (UNESCO, 2006). This enables teachers to better transmit *sustainable development information*, *principles and values* to pupils. Storytelling is especially good for pupils whose preferred learning modality is auditory. Remembering a list of isolated concepts and definitions may be difficult, but recalling the flow of a story related to these concepts may be easier for pupils. A story may also provide a non-threatening way to ease pupils into learning. Stories engage people of all ages and abilities.

Story telling is advantageous because it links to traditional and indigenous knowledge and passes wisdom from one generation to the next; engages learners with *cultural heritage* which is the fourth dimension of sustainability. A very important potential of primary school student is that they are auditory learners. Sustainability component, for example, predator-prey relationships can have a sustainability twist by telling a story of the consequences of the introduction of a fox to a hen house to take care of them. The concept of prey-predator may now be presented point by point progressing through the material. With practice, the pace of a story may be varied building in suspense through pauses to draw pupils' attention. A lesson can be structured with a storytelling component that illustrates the academic content.

Another potential of pupils in the primary schools is that they are full of *imagination,* that is, instead of providing the resolution to a story, pupils may be asked to imagine it, thereby allowing pupils to develop problem-solving and critical thinking skills. Teachers can ask questions such as 'what do you imagine will happen if……?' What do you think could have happened if another fox was added? Bringing the story back to the content of the lesson and the theme of *sustainability* is important. Teachers can ask, for example, how the story illustrates sustainability, its principles and values. Although the tie between the story and the content is obvious to the teacher, it may not be clear to the pupils.

It is important that the concept of sustainability exposed to children right from the Primary School because it is an over-arching paradigm that encompasses

Environmental, Social, Economic, and Political problems and issues that face communities around the world. When the pupils of today assume positions of leadership and become voters, they will have to deal with complex issues that have no simple answers. While in school, they should

develop the tools and frameworks for thinking in a way that will help them untangle the complexities of sustainability issues that face their communities. They will also need to learn to create solutions that are locally appropriate and at the same time keep in mind global consequences (Clark, 2000; Rosenberg, 2009)

Conclusion

The S&T community has a responsibility to provide the knowledge and technologies that will enable a long-term sustainable future. To this end, a basic requisite will be to establish long-term monitoring systems for collecting reliable scientific, socio-economic and other societal data. These systems must permit the integration of all relevant data sets for addressing crucial sustainability issues. The global environmental observation systems need to be made fully operational, which requires governmental funding. Full and open access to scientific information data must be ensured.

Larger investments in S&T should be seen primarily as increased investment in a country's socio-economic development and in preserving natural life-support systems for the present and future generations, rather than simply as research expenditures. For this reason, public sector funding for S&T activities targeted on sustainable development goals should be augmented significantly at all levels of education. The private sector should reorient its S&T investments in a manner, which integrates sustainable development objectives and should increase its S&T investments generally. Strategic partnerships should be forged between the public and private S&T sectors at national and regional levels.

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