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Relevance of Students' Scientific Literacy to Understanding of Environmental Sustainability: Implications for Curriculum Development

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Abstract
The study was carried out to find out the level of scientific literacy of Nigerian tertiary-level students and the relationship with their knowledge of global environmental sustainability issues of 21" century. Eighty-five tertiary level students were randomly selected from three faculties/schools from three institutions in Delta state of Nigeria. A modified Richard Carrier's internet fiddle test of scientific literacy was administered to the sample after an awareness programme on environmental sustainability had been given. A test of knowledge of environmental sustainability was administered two weeks later. The result revealed a very low scientific literacy level in the sample and a significant correlation coefficient between scientific literacy and environmental sustainability. Science and nonscience majors in the sample were found not to differ both in their scientific literacy level and in their knowledge of environmental sustainability. A broad-based curriculum flexible enough to accommodate contemporary issues of global interest was recommended among others.

Recent events in the world have led to a focus of attention on the need for greater efforts toward sustaining the environment. This, it has been realized is indispensable if man is interested in his continued existence and healthy living. Apart from his health, the need to conserve natural resources and endowments has also become expedient. The environment is the natural reservoir for plant life which is man's source of supply of medicinal herbs, food, and raw materials for industries. It is also the source of clothing, respiratory gases, mineral resources, aesthetics, and recreation as well as abundant knowledge for man in the quest for an understanding of his very origin and existence. Africa and Nigeria, in particular, are so richly endowed with good climate and resultant vegetation and natural resources that for a long time past little or no efforts are made in the area of sustainability. In this decade therefore and as a direct consequence of the Millennium development goals project (MDGs), attention is now drawn to the dangers the neglect of the environment (Okogwu, 2009). In November 2010, the Federal Government of Nigeria made a commitment to pay greater attention to its environment after a summit on the dangers of global warming. This is coming

at a time when the Nigeria Educational Research and Development Council (NERDC) takes a curricula dimension to the issue of the environment by the design and introduction of Environmental Education(EE) as a school subject to Nigerian secondary schools. This is a piece of good news to the science education community and all lovers of the environment. The goals of EE as conceived by the curriculum planners and recorded by Gbamanja (2003) include

1. Producing physically, psychologically, sociologically, and philosophically active individuals
2. Fostering clear awareness of and concern about economic, social political, and ecological interdependence in urban and rural areas.
3. Producing citizens whose values and attitudes are systematic to the responsible use of and management of environmental resources.
4. Providing the learner with experiences capable of developing the process skills necessary for scientific decision-making in the environment.
5. Providing everyone with the opportunity to acquire the knowledge, values, and attitudes to enhance the environment.
6. Creating new patterns of behaviours of individuals, groups, and society as a whole towards the environment.

The achievement of the above goals impinges on individuals' understanding of the implications of their actions and inactions in the environment. These goals draw attention to the need for improvement of scientific literacy among Nigerians as a fundamental basis for understanding the importance of environmentally friendly habits that promote sustainability.

Concepts of Literacy and Scientific Literacy

Literacy as an integrated construct consists of multiple practices, skills, and attitudes which are needed for performing and conceptualizing in various contexts (Brown, Hamilton, and Ivanie, 2000). These practices are those needed for exhibiting of certain levels of mastery in all contexts. Mackenzie(2009) identified twelve categories of literacy which include natural literacy, artistic literacy, media literacy, ethical literacy, visual literacy, numerical literacy, text literacy, social/cultural literacy, emotional literacy, organizational literacy, environmental literacy, and scientific literacy. On this premise, Mackenze's definition of literacy is 'the capacity to analyze, interpret and understand the information within a particular category of information or within a particular medium with each category requiring specific tools, concepts, and vocabulary to unlock the full meaning of the information is instructive'.

Obah (2008) sees literacy as a stimulant for initiative and mastery of human relations. Hazen (2002) and the American National center for Education Statistics describes scientific literacy as a mix of concepts, history, and philosophy that helps an individual understand the scientific issues of our time. It is the knowledge required for the understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs,

and economically productive ventures. specific attitudes associated with scientific literacy as summarized by Hazen (2002) include:

1. Asking answering questions generated by daily experiences
2. Describing, explaining, and predicting natural phenomena
3. Reading and understanding science publications in magazines and dailies
4. Understanding science implications of national and local decisions and laws
5. Evaluating the authenticity of scientific information that has implications for daily life.

Hazen's conception excludes in-depth knowledge or specialized knowledge in an area of science from scientific literacy. By implication, therefore, ignorance of broad knowledge of scientific issues from all areas of science amounts to scientific illiteracy. Environmental literacy focuses on the health of the planet, exploring possible ways to promote well-being and sustainability. There is some obvious overlap with scientific literacy (Onyeador 1997, Mackenze 2009) because understanding the environment requires a grasp of many important scientific principles and concepts

Evidence (De La Rosa 2000,Hazen 2002) shows that the scientific literacy level in literate cultures like America is unexpectedly low. The level of scientific literacy in Africa and Nigeria in particular where western science is still being grappled with needs to be investigated.

Broad access to scientific information is premium to peoples understanding and hitherto participation and response to challenges posed by present-day civilization such as global warming, biodiversity, evolution, conservation, health, and healthy living etcetera. De La Rosa (2000) and Onyeador (1997) asserted that the net result of a scientifically illiterate society is the inability to keep up with the effects that accelerated development has on their environment which ultimately will affect their own sustainability. The inability to access, understand, utilize, and benefit from scientific research, facts and advice endangers the development and growth of a nation. Every discipline has some scientific undertone as knowledge exists in a milieu. Success in any field requires a degree of scientific literacy to achieve. On the other hand, environmentally literate people:

> *routinely evaluate the impacts and consequences of actions gathering and synthesizing pertinent information, choosing among alternatives, advocating action positions, and taking actions that work to sustain or enhance a healthy environment. Such people demonstrate a strong, ongoing sense of investment in and responsibility for preventing or remediating environmental degradation both personally and*

collectively, and are likely to be acting at several levels from local to global in so doing (Roth 1992).

The focal point of this study is to open an understanding of the scientific literacy level of Nigerian students as elites of tomorrow and their knowledge of sustainability issues as it relates to their preparedness to tackle environmental challenges of development and exploration, especially in the oil-rich Niger Delta.

Statement of the Problem

The World Bank reports on Nigeria in 1996 that "Nigeria represents a paradox. The country is rich but the people are poor. Nigeria is rich in land, people, oil, and natural gas resources…But poverty is pervasive in all the regimes to different degrees" is food for thought for all positive minds in Nigeria. The inability to make effective use of the vast resources to lift the nation above poverty is worrisome (Moemeke, 2010). The ability to tap natural resources for economic and other purposes requires awareness and literacy in science and science concepts. More so is the need to understand the implications of pollution, deforestation, illegal mining, oil spillage, wanton destruction of wildlife, etc on human life and well-being (Environmental literacy). The necessary knowledge base to guard against habits and decisions inimical to sustainability seems to be suspiciously low among the citizenry. Though Nigeria's government is a signatory to global goals on the environment, only environmentally friendly practices and scientifically literate citizenry can make right decisions about their environment and support their leaders' efforts towards achieving the goals. The students in Nigerian tertiary institutions could be a steering group toward achieving this since they are the workforce of the future. The desired attributes of the 21st-century workforce are quite different from those used by industrial societies. The quest is to produce individuals with the capabilities to face the challenges of the scenarios posed by post-modernization and post-industrial era. The question now is: to what extent are these students scientifically literate? Is there a relationship between the student's area of study and their awareness of environmental issues of our time? These questions are apt considering Okogu (2009) summary on meeting the challenges of the MDGs which showed that indications in Nigeria on targets 7a (with a target date of 2010) and 7b (with a target date of 2015), both relating to environmental sustainability are worsening. This is more disturbing realizing that the United Nations has declared the years between 2005 and 2014 as the "Decade of Education for Sustainable Development

Research Hypotheses

The following null hypotheses guided the study.

1. There is no difference in the proportion of Nigerian tertiary-level students who are scientifically literate and those who are not.

2. There is no difference in the proportion of males and females tertiary-level students who are scientifically literate.
3. There is no relationship between students' level of scientific literacy and their knowledge of environmental sustainability issues.
4. There is no significant difference in science and non-science students' scientific literacy levels and their awareness of environmental sustainability.

Purpose of the Study

The study is directed towards finding out if students' level of scientific literacy in any way influences their understanding of environmental sustainability. It also aims at finding out the literacy level of Nigerian students in tertiary institutions of learning so as to enable an understanding of any possibility of meeting the environmental sustainability goals.

Method of the Study

Eighty-five 300-level students of three out of the seven tertiary institutions in Delta state were selected for the study by stratified random sampling technique from three faculties/schools. A survey design was employed and a 24-item test of scientific literacy modified from Richard Carrier's (2001) internet fiddle on scientific literacy was administered to the sample after a general awareness lecture on our environment had been given. Newspaper clips on challenges on the environment were distributed to the sample.

Two weeks later, a 23-item test of knowledge of environmental issues (TEI) was administered. The first ten items in the questionnaire tested knowledge of current global issues on the environment from current themes like climatic change and human continuity, forest preservation and maintenance of species, natural ecosystem, and species diversity, human ecology (diseases and therapy), greenhouse effect and man, conservation of natural resources, technology and pollution, mineral prospecting, crude oil, and oil spillage. The remaining items sought respondents' views on maintaining a friendly and sustainable environment through environmentally friendly practices.

The reliability of the two instruments was calculated. The modified Carrier (2001) scientific literacy test was found by Cronbach alpha to be 0.68 while TEI was 0.70. Data collected was analyzed descriptively using percentages and Pearson product-moment correlation for the test of the relationship.

Results

Table 1: Frequency and Percentage Of Scientific Literacy By Sex

Sex	**Male**		**Female**		**Total**	
Area of specialization	**High literacy (%)**	**Low literacy (%)**	**High literacy (%)**	**Low literacy(%)**	**High literacy (%)**	**Low literacy %)**
Science Major	9(50)	9(50)	11(55)	9(45)	20(69)	18(31)

Non Science Major	10(40)	15(60)	8(36)	14(64)	18(38)	29(62)
Total	19(44)	24(56)	19(45)	23(55)	38(44)	47(59)

Table 2: t-test of Significance of Environmental Sustainability of Science and Non-Science Groups

	x	**SD**	**N**	**df**	**Cal t-value**	**Critical t value**
Science	56.69	2.08	**35**	**83**	**0.002***	**1.96**
Non-science	53.3	9.37				

***Significant at P<0.05**

Table 3: t-test of Significance of Scientific Literacy of Science And Non-Science Groups

	x	**SD**	**N**	**df**	**Cal t-value**	**Critical t value**
Science	11.74	3.92	**35**	**68**	**0.051***	**1.96**
Non-science	56.693	2.08				

***Significant at P < 0.05**

Table 1 above showed that of the 85 students in the sample,38 representing 44% show evidence of scientific literacy at the 50% cut-off mark while 47 (59%) were scientifically illiterate. Hypothesis 1 which stated that there is no difference in the proportion of scientifically literate and illiterate students was rejected. There exists a difference in the proportion of students in the two categories.

There is statistical evidence from Table 1 that shows an equal proportion of males and females who made the 50% literacy mark set for the study. The hypothesis of no difference is thus retained. Less than half of the population of both sexes is scientifically literate. The slight difference in favour of girls is infinitesimal and is attributable to sampling error.

In determining any possible relationship between the two scores, Pearson r of -0.38 indicated a negative relationship. The hypothesis of no difference was rejected since a relationship actually exists but in the inverse direction. This calls for further investigations in subsequent studies. In terms of hypothesis 4 which investigated the significance of the difference in scientific literacy of science and non-science majors, the t-test of comparison (Table 3) showed a calculated t-

value of 0.764 which is less than the critical value (1.96) at 0.05 alpha levels. This signifies no significance of the difference between science and non-science majors in terms of their science literacy levels. This trend is maintained in the knowledge of environmental sustainability issues (table 2) of the groups along the disciplines.

Discussion of Findings

The findings from this study show a very low scientific literacy level among Nigerian students. This is attributable to the way Science is taught at foundational levels of education. Science is still perceived as a body of facts. The process of science and the nature of science is still at an abysmal level. Very worrisome is the low scientific literacy level among Science majors. This however is in line with Carrier (2001) and Hazen (2002)who reported poor scientific literacy among specialists in single-subject science subjects even in western cultures. The way science is taught indicates how it is conceived and affects how much science the individual is able to do. In addition to this, the low knowledge of environmental sustainability (literacy) issues in the sample show that most of the respondents do not possess enough science knowledge to appreciate its meaning and importance. The negative correlation between scientific literacy and environmental sustainability is unexpected and needs further investigation. What is understood from this finding is that maintaining sustainability is attitudinal and goes beyond knowledge of facts and principles. It is the application of this knowledge that builds the habit of attention to the environment as a human resource. There also seems to be a disconnect between classroom knowledge and attitude and out-of-class utilization of science knowledge. This may have implications for the curriculum of all levels of education.

Conclusions

Scientific literacy can be considered the main goal for 21st-century science education and the demand of post-industrial society. Moreover, it seems to be requisite to foster education for sustainability throughout formal education. An integrative, inter/transdisciplinary epistemological curriculum approach, is necessary to allow the citizens to understand and participate in the discussions about the complex contemporary issues posed by post-industrial society such as environmental sustainability. Education for sustainability asks for exploring the new interfaces among science, technology, society, environment, and ethics. There is a need to change the curriculum in higher education and improve scientific literacy through strategies to promote dialogue and critical thinking. The recent explosion of scientific knowledge and the new paradigms of post-industrial society has imposed new challenges on education. Knowledge of environmental sustainability issues and literacy in science are top issues for man's continued existence and welfare.

Recommendations

Based on the finding emanating from this study, the following recommendations are made.

1. The study showed that there is a relationship between scientific literacy and knowledge of environmental sustainability suggesting that both could be nurtured through formal education
2. There is a need for curricula revisions that will broaden the science curriculum at the primary and secondary levels for a general understanding of the issues of modern global discourse. Integration might provide an answer to narrowness and early specialization.
3. Libraries and free internet facilities should be provided in tertiary institutions so that students could have free and easy access to current information about global issues
4. The implications of science and scientific literacy are enormous in this post-industrial and knowledge age and an uninformed society is more devastating than an earthquake. For this reason, general studies courses in the tertiary institution should be revised and flexible in content to enable infusion of contemporary issues that affect human existence and wellbeing
5. Science majors must diversify their knowledge base for meeting the challenges of the present and future. This can be achieved through frequent seminars, conferences, enlightenment, and mass orientation as well as the formation of clubs and societies for the protection of the environment and sustainability.
6. The Ministry of Environment and the Mass Media should be reorganized to meet the task of information dissemination about global environmental issues.

7. Individuals should sponsor advertorials on scientific knowledge for sustainable development.

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