

# **Actualizing the Effective Learning of Science in a Globalized World: The Place of the Nigerian Indigenous Science**

**BY**

**\*FRANCISCA ALADEJANA and CECILIA ODEJOBI  
INSTITUTE OF EDUCATION  
FACULTY OF EDUCATION  
OBAFEMI AWOLowo UNIVERSITY  
ILE-IFE, NIGERIA.**

**\*Corresponding author**

**E-mail: [faladeja@oauife.edu.ng](mailto:faladeja@oauife.edu.ng)  
[faladeja@yahoo.com](mailto:faladeja@yahoo.com)**

**Key Words: Effective learning, school effectiveness, indigenous science, prior knowledge, globalization, alternative conception.**

## **Abstract**

The paper examined how the learning of Western science can be more effective in Nigeria. The objectives therefore are to determine teachers' perception of what constitutes students' prior knowledge in terms of diversity of knowledge, identify the types of prior knowledge and the relevance or otherwise of such conceptions to science. A questionnaire was administered on 450 Junior Secondary Schools (JSS) One students to assess the prior knowledge they bring from their different indigenous science cultures into science learning and on JSS III students to assess the alternative frameworks they still hold on to after three years of learning of integrated science. Data was also collected from science teachers and purposively selected adults. Data analysis was done using descriptive statistics. Findings from the study revealed some alternative conceptions that some Nigerian children bring to the science classroom and that such conceptions often remain after being exposed to Western science. The study also identified teachers' perception of learners' prior knowledge, differences between indigenous and Western science and aspects of indigenous science that can positively influence the learning of modern science. The implications of these findings for effective learning of science, curricular reform and globalization are discussed.

## **Introduction**

Science and technology determine development as science has been described as the arrow of time to measure development, both dominate the globalized world and countries invest heavily on them. In spite of this, most technologies in Africa are borrowed and performance of learners in science subjects is generally poor. Even though there are a few recognized African scientists, technologists and educators, on the whole, the continent continues to be that of subsistence farmers and pastoralists. There is the need to ensure that the quality and quantity of learners that go into science are improved for better scientific and technological development, hence, the need to look into effective science learning.

## **School Effectiveness and Effective Learning**

School effectiveness is becoming a priority for any educational policy of a country as reflected in the National Policy on Education (2004) which identified as one of Nigeria's Philosophy of Education the believe that there is the need for functional education for the promotion of a progressive, united Nigeria; to this end, school programs need to be relevant, practical and comprehensive. According to the policy, Nigeria's Philosophy of Education is based on the development of the individual into a sound and effective citizen.

According to Creemers (2003), school effectiveness is strongly focusing on student outcomes, the characteristics of schools and classrooms that are associated with these outcomes. It thus tries to find out what is to be changed in schools in order to become more effective. School effectiveness may have different meanings to different people, thus the perspectives of effectiveness may vary from the education authority to the teacher and to the parents. It may also vary from economists to instructional psychologists. Whatever perspective is taken, the product, what learners have gained from their years in school in terms of both cognitive and affective

areas, although the criteria used to measure performance may vary, should ultimately judge effectiveness. (Driver, 1991, Scheerens, 2000)

What learners gain in the cognitive area in a school is determined largely by how effective the learning process is. According to Education Queensland (2004), one of the basic principles for effective learning is the need to shape and respond to a variety of social and cultural contexts such that amongst other things, individual diversity as well as the perspectives, contributions and experiences of diverse social and cultural groups are included and valued. Also Downes (2005) identified three keys to effective learning as interaction, usability and relevance. Relevance is an essential ingredient of any meaningful programme to have the required impact on the learner and society. According to Ausubel (1968), the most important single factor influencing learning is what the learner already knows; ascertain this and teach him accordingly.

Therefore, in order to make the learning of Western science effective in the Nigerian context, there is the need to shape it such that the diverse social and cultural groups are included and valued. According to Scheerens (2000), measures of school effectiveness are based on comparative rather than absolute standards. Western science seems to agree with the culture and tradition of the western world, therefore, if the learning is to be comparatively effective in Nigeria, there is the need to take cognizance of the indigenous science, which is often different from what is learnt in Western science.

Various factors contribute to effective and meaningful learning in the school; one major identified factor is the prior knowledge of the learners. This does not just involve what was learnt in the previous lessons but also the diversity of knowledge that the learners hold especially from their culture. According to Scheerens (2000), culture is one of the models of schooling that may be manipulated by the school or agencies that have control over the school to achieve

effectiveness. Thus, the prior knowledge of the learner derivable from the culture in science classroom, which is often the indigenous science, is one factor that can be manipulated to ensure that modern science is effectively learnt.

Two of the inputs which are recognized educational domains in the school to achieve efficiency, the curriculum quality and instructional methods are especially important in terms of recognizing and manipulating this prior knowledge of the learners. It is necessary for the curriculum-planners to be aware of learners' own deep-seated beliefs to ensure that these beliefs do not interfere with objective science teaching. It is better to bring this knowledge to light and build upon it rather than ignore them as if they do not exist even when they appear to differ from scientific principles. According to Bass (1999), a lot of Africa's problem will be solved through the fusion of Western science with Africa's traditional strengths. According to Odhiambo (1967), one of the possible reasons why there are few African scientists is that there may be something in their cultural attitude and social philosophy that may discourage a tradition in science.

### **Indigenous Science**

Indigenous science and technology in Nigeria are part of the knowledge which people have developed over time especially pre-colonialisation but with the advent of missionaries, they have adopted Western science which had almost totally eradicated the indigenous science from the people. However, many scientific phenomena (lightning, causes of diseases etc) are still explained with beliefs from indigenous science as it constitutes part of the way people can understand the world; they still value these beliefs and ideas and are often willing to pass them on. Indigenous knowledge has been described as a cumulative body of knowledge, know-how, practices and representations maintained and developed by people with extended histories of interaction with the natural environment (ICSU Study Group, 2002). It covers many

fundamental aspects of day-to-day life like hunting; fishing; farming, conservation of food, medicine and cure of diseases, water storage, metallurgy, building, technology, leisure, play and trade.

Many aspects of indigenous science have been found to be useful and at times relevant to western science. According to Emeagwali (2003), in Funtua Northern Nigeria, people are well known for and are still using medical expertise in orthopedics; the Yorubas of Western Nigeria had vigesimal calculation while others had calculations to base 10, and systems of logic have been manifested in games such as 'ayo'. Other examples are fermentation and the use of metallic objects to hasten fermentation, frying and dejuicing methods for food preservation, smelting by the use of bellows and heating furnaces, massive earthworks and fortifications of Benin and Ijebu-Ode in Nigeria. In the field of medicine, African traditional healers had invented the "talking cure", free association, group therapy and behavioural modification long before Sigmund Freud and his successors. Bass (1999) identified some relevance of indigenous science to modern science to include 1000 year-old-culture of people in Timbuktu, Mali who have written texts which are today models of environmental conservation and the over 1000 animal, plant and mineral products for the treatment of illness that western-trained scientists are avidly studying.

The consensus of many educators is that culture plays a central role in science and technology education and that there is the need to understand the fundamental, culturally based beliefs about the world that students bring to the class. This is because science education is successful only to the extent that science can find a niche in the cognitive and socio-cultural milieu of students, hence the role of indigenous knowledge in teaching and learning, (Cossons, 1993; Cobern, 1993; Swift, 1992). However, some of the prior knowledge the learners bring to

science classroom from indigenous knowledge have been found to be connotations of wrong ideas and beliefs about how things happen which are at variance with conceptions held by experts in the field of science. They are termed alternative conception and are most often held on to even after exposure to Western science (Blosser, 1987; Lawson and Weser, 1990; Aladejana and Ehindero, 1995 Jegede, 1998).

### **Globalization and Science**

Western science has turned the world into a global village. According to Brock-Utne (2004), corporations, markets, finance, banking, transportation, communications and even diseases cut across national boundaries, this is globalization. According to Axford (2000), globalization is the historical process whereby the world is being made into a single place with systemic properties. If then the world is turning into a single place, the implication is that it will precipitate changes in consciousness and possibly in identity. This however should not be taken to imply homogeneity, rather to a global system, which has a number of configurations sometimes overlapping but often confronting each other.

Science is at the core of globalization for few moments of our lives and activities are untouched by the products and processes of science. It becomes imperative that all must be at least scientifically literate and a nation must go beyond this to be scientifically and technologically developed. To achieve these, all options must be explored to ensure that learners learn science effectively and that no group of learners is at a disadvantage in terms of effective learning. Ignoring indigenous science is one way in which Nigerian learners can be disadvantaged; instead it should be incorporated into curriculum and texts.

## **Objectives of the Study**

According to Michie (2002), the aim of science is to promote consideration of the differing worldviews, not solely to enrich Western science but to facilitate a two-way exchange of knowledge and of cultural understanding. UNESCO (1961) recommended that African educational authorities should revise and reform the content of education in the areas of curriculum, textbooks and methods so as to take account amidst other things of the African environment and cultural heritage. According to Rollnick (1998), this view negates the positivists' view that science is a value-free subject. Even though the curricula of integrated science in primary and junior secondary schools in Nigeria have a lot of native input in terms of teaching resources, the ideas of indigenous science are not adequately reflected in them.

It would be interesting to examine indigenous science in some details to see why it is rejected as science and also whether it can be useful to science. This study therefore examined how the learning of Western science can be more effective in Nigeria such that the students are learning the science that makes the world a single place.

The specific objectives of the study are to:

1. determine teachers' perception of what constitutes students' prior knowledge in terms of the diversity of knowledge.
2. identify the type of prior knowledge students come to the science class with and determine whether or not such conceptions are still held after learning Western science
3. differentiate between Western and indigenous science.
4. assess the relevance or otherwise of such conceptions to Western science

## **Theoretical Frameworks**

The study is based on some theoretical frameworks; one of these is the Knowledge Base Theory. The knowledge base, according to Jegede (1998) is not only a distillation of ideas; rather it is an accumulation of information and practices from which learners can draw to aid further learning. It is therefore content-oriented and affected by context. A knowledge base should encompass information derived from the instructional, sociological, anthropological, cultural and psychological elements of a society. In Africa, the knowledge base for schooling should draw from traditional and current belief, taboos, superstitions, customs and traditions. According to Kerderman and Phillips (1993), the Western view of a knowledge base includes only evidence that can be transformed empirically into knowledge that experts deem credible. To teach science and technology in African schools with such a narrow definition is to ignore what catalyses learning within the student's environment. Various studies have shown that the socio-cultural factors of a learner's environment significantly affect achievement in schoolwork (Jegede, 1995 and Ogbu 1992).

Constructivism is another theoretical framework. According to Thomas (1992), higher order learning is not just a change in behaviour but the construction of meaning from experiences. For construction of new knowledge, learning is dependent on the existing knowledge base. According to Ritchie (1994), constructivism is an epistemology that focuses on the role of learners in the personal construction of knowledge. Learning is viewed as an adaptive process where existing knowledge is modified in response to interaction. Contemporary views of learning postulate that people construct new knowledge and understanding based on what they already know and believe (Piaget, 1978; Vygotsky, 1978; National Research Council, 2000; Libarkin, and Kurdziel, 2001). According to Jegede (1998), this implies that the learners'

understanding of any new meaning is strongly influenced and determined by prior knowledge that is in turn determined by cultural, belief, traditions and customs governed by a world-view. Prior knowledge therefore varies between groups, and that which the African learner often brings to science class is not in consonance with the concepts being discussed, thus, this will affect the way an African learner creates meaning in a Western science class.

The theoretical framework of multidimensional approach to globalization is relevant to this study. According to Axford (2000), this approach does not privilege any one domain as providing the key or essential dynamics of globalization, but addresses the complex and often contradictory interplay between economic, political and cultural forces in making the world one place. The approach does not see globalization as a situation where all differences between local structures are dissolved and individuals become interchangeable at an abstract global level. This configuration of globalization on which the study is based is that which depicts a globalized world where existing identities can be indigenized or used by local actors to meet their own needs (Hannwerz, 1996). In this configuration, relationships between the local and the global are structured in and there is the claim that local culture has an authentic quality while global cultures are by definition protean and thus inauthentic (Axford, 2000).

## **Methodology**

The instruments of study are a 30-item structured students' questionnaire (SQ) with Yes or No responses designed to assess the prior knowledge learners bring from their different cultures into the science classroom and a 15-item open-ended teachers' questionnaire (TQ) designed to identify teachers' perception of what constitutes learners' prior knowledge. The questionnaires were validated by other science educators while their reliability using the test-retest method in a pilot study gave the reliability coefficient of  $r = 0.91$  (SQ) and  $r = 0.89$  (TQ).

SQ was administered on 450 randomly selected junior secondary school (JSS) one students. It was also administered on an equal number (450) of randomly selected JSS III students who have already completed three years of JSS Integrated Science to assess any alternative conceptions they still hold on to after the learning of some Western science.

TQ was administered on the 25 science teachers of the selected learners. Both teachers and learners were selected from 10 randomly selected secondary schools in rural locations of Southwest Nigeria where culture still has a great influence on the thinking of learners. Also a guided interview was conducted with 20 purposively selected adults based on the criterion of being conversant with indigenous science. Data analysis was done using descriptive statistics.

## **Results**

Findings from the study showed that 76% of the teachers are of the opinion that what they recognize as prior knowledge in their science classes are topics which learners had been taught previously in the class while 24% agreed that prior knowledge includes both things learners have learnt from the classroom and also from their culture. All the teachers agreed that they normally start their lessons by briefly going over the previous work before starting a new topic. However, only 28% agreed that they discuss conceptions, which students bring from their various cultures while 72% do not address such conceptions. It was also found that 48% of the teachers agreed that it might be necessary where the need arises to use topics taught in the science class to explain conceptions in indigenous science and to assess the relevance of conceptions in indigenous science to Western science while 52% of them are of the opinion that such an exercise will be time wasting as it is not required in the curriculum and students do not require such for examination purposes. Many of them would rather concentrate on teaching learners to pass their examinations.

Data analysis of JSS I students' responses indicated that all of them (100%) came to science class holding between 20.5 – 50.1% of their conceptions from indigenous science. Analysis of the JSS III students' responses showed that all the students (100%) still hold conceptions from indigenous science about topics already taught in Western science but at a slightly lower percentage of 20.1 – 40.7%. The various types of conceptions about natural phenomena which students' hold and which are alternative conceptions to scientific conceptions include:

1. Heredity can be explained in terms of a dead relative reincarnated as a new child.
2. The blood (not genes) carries hereditary characters from parents to off springs; hence carriers of heredity are located in the blood.
3. A dominant character in inheritance implies the character of the parent with the stronger blood.
- 4 A couple with all-female children is attributed to and blamed on only the mother.
- 5 Thunder and lightning are not caused by high cloud called cumulonimbus but caused by the god of thunder ('sango').
- 6 Events in nature are predetermined by divine guidance.
- 7 Most sicknesses and deaths especially of young and middle aged people do not occur naturally, they are likely to be caused by some evil force.
- 8 Any child with a major deformity is likely to be a spirit/demon, not any genetic problem.
- 9 Spider is an insect like ants, butterfly, and cockroach.
- 10 Some animals possess strange powers and so cannot be toyed with like cat.
- 11 Hurricanes, flood, typhoons are caused by water spirits that need to be appeased.

- 12 A man cannot have fertility problems; inability to have children is attributed to the woman only.
- 13 Sex is prohibited during menstruation as it leads to giving birth to an albino, as against being caused by gene mutation.
- 14 Children of the same parents dying from sickle cell disease is said to be a phenomenon called 'abiku' implying that it is the same child that is born over and over and dying.
- 15 God creates all living things and so the question of evolution in any form does not arise.
- 16 Plants cannot be considered the type of living things man is.
- 17 Man cannot share the same ancestor with other primates like chimpanzee and monkey.
- 18 The fighting of the sun and the moon causes an eclipse.
- 19 Plants do not move (one of the characteristics of living things) as they stay in one place.
- 20 Force and energy are the same concepts. Thus they talk of water moving with great force, the girl is talking with force.
- 21 Objects fall down because there is some power in the ground that pulls them to the ground. They see gravity and force as synonymous.
- 22 Heat and temperature cannot be clearly differentiated from each other.

Analysis of Responses from the adults' interview and the TQ showed that there are some major differences between Western science and indigenous science as shown in Table 1.

**Table 1: A Comparative Analysis of Western and Indigenous Science**

	<b>Western Science</b>	<b>Indigenous Science</b>
1	It is transmitted by writing	Transmitted orally
2	There is division into disciplines: physics, chemistry, biology, agriculture, technology, engineering, medicine, pharmacy, microbiology etc	Holistic approach embracing agriculture, communication, cloth making, dyeing, crafts, pottery, medicine, technology, manufacture of soap, wine, blacksmiths etc
3	Reality is not based on spiritual forces	Almost all things can be traced to some supernatural force
4	Accepts only those things that can be empirically proved.	Knowledge is not subject to empirical analysis before acceptance.
5	Objective assessment of situations without recourse to any divinity	Strong belief in God/gods and the need to make sacrifices to appease such gods.
6	An individual does not reincarnate	Strong belief in life after deaths (as reincarnation)
7	Breakthroughs and findings are not personal but are usually published	There is ownership of inventions, and no obligation to release such information

The results also showed that some aspects of indigenous science are relevant and in agreement with Western science as shown in Table 2.

<b>Indigenous Science</b>	<b>Modern Science</b>
1. (a) Making pots for cooking that can withstand and maintain hotness  (b) Making pots that provide cooling effect for water	These pots are made of clay. The important characteristics of clay that make these properties possible for the pots are: -- high water retention capacity -- fine soil particle size -- low porosity
2. Making black soap using cocoa pods, melon pods, kernel oil	Saponification process in chemistry involving the preparation of soap using oil (palm kernel oil)
3. Local wine and gin are brewed from plantain, maize, guinea corn and palm wine	This involves the process of fermentation that is used in modern day breweries.
4. Making dyes from various leaves to colour clothing.	Extraction of colours from leaves using various chemicals.
5. Blacksmiths making knives, cooking utensils, pots, jewelry, cutlasses, bows and traps from metal products like tin, brass, iron, steels.	Various techniques and scientific principles are involved in these activities. For example Bellow principle produces strong currents in air in the context of an air chamber expanded to draw in air through a valve or to expel it.
6. In agriculture : Use of manure; covering yams heaps with leaves against heat; identifying seasons and times for planting and harvesting; keeping diversities of yams in barns for storage, growing crops in combinations and sequences.	All of these are carried out in modern agricultural practices and given special terminologies e.g. Manure, mulching, and crop rotation.
7. Indigenous mathematics (a) Counting yams in sets of 50,100, 200; selling yams in sets of 3 or 5 (b) using strokes to count e.g. ###  (c) some system of calculation to base 10 as in the Yoruba system.	Set theory in mathematics  This is tally making used in statistics for grouping of frequency. Regular mathematics calculation is in base 10
8. Classification and Nomenclature of many living things are done in Yoruba, Nigeria to reflect two names such as “eran osin”-domesticated animal, “eranko igbe”-undomesticated animal.	There is the binomial system of nomenclature.

## **Discussion**

The study showed that most of the teachers recognize the importance of prior knowledge as important for meaningful learning to take place. They generally take cognizance of this when beginning a new lesson by briefly reviewing what students have learnt in previous lessons and building upon it. However, only a few of them accept that conceptions which learners hold from their cultures and indigenous science constitute part of what they should recognize as the learners' prior knowledge for instructional purposes. One major reason given for this is the fact that they do not form part of the curriculum or any of their recommended texts. This finding indicates that the teachers are aware that learners have a knowledge base from which learners can draw to aid or deter further learning.

However, the content of the knowledge base, which most teachers recognize, encompasses only information derived from the instructional setting, which is the Western view of knowledge base. This is contrary to the views of Jegede (1998), which have knowledge base derived from sociological and cultural elements of the society.

The implication of this is that whatever information learners have that are from indigenous science are not likely to be considered in the science classroom. Learners therefore will possibly not be able to grasp the relevance of science to their day-to-day life and beliefs. They also might not be able to use science to solve problems and understand various phenomena. In this type of situation, many students in Nigeria might not be learning science effectively, probably not be able to develop into effective citizens as the National Policy on Education (2004) recommends and may be at a disadvantage comparatively to their counterparts in the Western world whose prior knowledge is in consonance with Western science. In terms of the assessment of output, the schools may not be effective.

Also, recognizing only the Western view of prior knowledge amounts to privileging one domain, which is contrary to the multidimensional approach to globalization on which this study is based. Differences between local structures of knowledge were found to be dissolved and unrecognized such that indigenous science has lost its own identity contrary to the views of Axford (2000). This might lead learners to construct new knowledge ineffectively as their knowledge base is not fully accommodated in the learning process. The implication of this is that learning of science will be ineffective as opined in various works such as Education Queensland (2004), Downes (2005), Ausubel (1968) and Cossons (1993).

The fact that information about indigenous science is not reflected in the curriculum and selected texts have been given as a possible reason why many teachers do not reflect this in their instructional activities. The curriculum is presently not promoting the idea of merging the two world views into science as suggested by Jegede (1998) and Michie (2002) rather it is in line with the positivist's view of not taking into account culture and environment.

The study has confirmed that in the present setting, learners bring to the science class prior conceptions they hold from indigenous science. Some of these conceptions have been found to be at variance with Western science and they represent the diversity of knowledge that can occur in such classrooms based on the indigenous science. Also, it was found that even after passing through three years of studying integrated science, many of the students still hold on to these alternative conceptions they have brought from their indigenous science. This agrees with the earlier findings of Lawson and Weser, (1990); Aladejana and Ehindero (1995) that learners bring to science classes alternative frameworks which tend to remain after exposure to Western science.

The identified alternatives conceptions can be broadly grouped into fours:

- (a) Those that attribute spiritual cause to situations and events such as sickness, death, accidents, natural disasters and fertility
- (b) Belief in the supernatural God such as creation and destiny
- (c) Belief in life after death such as the 'abiku' syndrome, reincarnation.
- (d) Man is not an animal as learnt in classification and evolution.

These findings about the diverse views of science agree with earlier findings of Jegede (1998)'s analysis of the four fundamental features of indigenous science. Thus, alternative conceptions of Western science abound rather than ignore them, accepting them, as learners' prior knowledge in the class will go a long way to make learning effective.

The study has identified six ways in which Western science differs from indigenous science. These are that indigenous science is transmitted orally, has holistic approach, trace most things to supernatural forces, does not subject knowledge to empirical analysis, believe strongly in reincarnation and God/gods and has a culture of secrecy. All of these are diverse from Western science and makes it important to make learning effective.

### **Conclusion**

Most teachers' perception of what constitutes students' prior knowledge does not recognize the diversity of knowledge from students' various cultures. These perceptions can be either relevant to the classroom science or are alternative conceptions which do not agree with scientific principles. Such alternative conceptions usually arise from learners' ideas, beliefs and thinking from indigenous science and they tend to remain even after exposure to Western science. Indigenous science is found to differ in some fundamental ways from Western science.

Therefore, in order to achieve school effectiveness such that learners in the Nigerian context can learn science effectively as many of their global counterparts, their two worldviews

of science must be incorporated in the classroom such that their total knowledge base is taken into consideration when constructing meanings. This should be reflected in the curriculum, the texts and the instructional process. The learners are likely to be effective citizens when they can perceive the relevance of the science they are learning in the class to their day-to-day activities, use it to reason and solve problems. The ultimate goal of this will be to stimulate and maintain students' interest in science, which will eventually lead to improvement in the quality and quantity of learners that go into science. This will be a step in the right direction for a nation like Nigeria that needs scientific and technological development.

### **Recommendations**

Based on these findings, the following recommendations are made:

1. Teachers should recognize the prior knowledge of learners as including diverse knowledge from their cultures. They must have knowledge of the common relevant ones and the alternative conceptions and both should serve as knowledge base for their teaching. Students should be actively involved in discussions at the beginning of and during the lessons such that their ideas can be sifted.
2. The curriculum should be designed to inculcate all common conceptions of learners. Textbooks should complement the curriculum.
3. Teachers should use innovative teaching methods and instructional materials that will make learning relevant to the common relevant and alternative conceptions of the learners. They should try to help learners to reconstruct where possible and internalize their new knowledge based on scientific principles.

## References

- Aladejana, F.O. and Ehindero, O.J. (1995): Students' Conception of Genetic Phenomena. *Ife Journal of Theory and Research in Education*. Vol. 4, Nos 1 and 2, p. 39 – 44.
- Axford, B. (2000): Globalization, In Browning, G., Halcli, A and Webster, F. (eds.) *Understanding Contemporary Society: Theories of the Present*. London, P 238 – 251.
- Ausubel, D. (1968): *Educational Psychology: A Cognitive View*, New York: Holt, Rinehart and Winston.
- Bass, T.A. (1999): Indigenous Science: A Star in Africa's Future? Online <http://file://A:\indigeneous%20science.htm>.
- Blosser, P.E. (1987): Science Misconceptions Research and Some Implications for the Teaching of Science to Elementary School Students. ED282776 *ERIC/SMEAC Science Education Digest, No 1*.
- Brock-Utne, B. (2004): Peace Education in an Era of Globalization  
mhtml :file://A\Transcend%20articles.mht.
- Cobern, W.W. (1993) Contextual Constructivism: The Impacting Culture on the Learning and Teaching of Science in Tobin, K (ed.) *The Practice of Constructivism in Science Education*, Washington, DC: AA Press. P. 51 – 69.
- Cosson, N. (1993): Let us take Science into Culture. *Interdisciplinary Science Reviews* 18 (4), p. 337– 42.
- Creemers, B. (2003): A Comprehensive Framework for Effective School Improvement. *New Perspectives for Learning –Briefing Paper 27*. <http://www.pjb.co.uk/npl/index.htm>
- Downes, S. (2005). Some Principles of Effective E-Learning, Canada, *National Research Council*, <http://www.downes.ca/cgl/website/page.cgi?db.....>
- Driver, E. (1991): School Effectiveness: Criteria and Evidence. A Discussion Paper, Scottish Council for Research in Education. Mhtml:file://A\ school%20Effectiveness\$20Criteria
- Education Queensland (2004). Principles of Effective Learning and Teaching. Online <http://education.qld.gov.au/sitemap/>
- Emeagwali, G. (2003). African Indigenous Knowledge Systems: Implications for the Curriculum. In Fatola, T. (ed), *Ghana in Africa and the World: Essays in Honor of Adu Boahen*, New Jersey, African World Press.

- Federal Republic of Nigeria (2004): *National Policy on Education*, Yaba, Lagos: NERDC Press.
- ICSU Study Group (2002): Science and Traditional Knowledge. Report from the ICSU Study Group on Science and Traditional Knowledge.  
[http://www.icsu.org/Gestion/img/icsu\\_DOC\\_Download/](http://www.icsu.org/Gestion/img/icsu_DOC_Download/)
- Hannwerz, U. (1996): *Transnational Connections*, London: Rutledge.
- Jegede, O. (1995): Collateral Learning and the Eco-Cultural Paradigm in Science and Mathematics Education in Africa. *Studies in Science Education*, 25 p. 97-137.
- Jegede, O. (1998): The Knowledge Base for Learning in Science and Technology Education. In Naidoo, P and Savage, M. (eds.), *African Science and Technology into the New Millennium Practice, Policy and Priorities*. Kenwyn, Juta and Co. Ltd. p.151 – 176.
- Kerberman, D. and Phillips, D.C. (1993) Empiricism and the Knowledge base of Educational Practice. *Review of Educational Research*, 63 (3), p. 305-13.
- Lawson, A.E. and Weser, J. (1990). The Rejection of Non-Scientific Beliefs about Life: Effects of Instruction and Reasoning Skills. *Journal of Research in Science Teaching*. Vol. 27(6). p. 589 – 606.
- Libarkin, J.C. and Kurdziel, J.P. (2001): Research Methodologies in Science Education: Assessing Students' Alternative Conceptions. *Journal of Geosciences Education* Vol. 49 (4) 378-383.
- Miche, M. (2002). Why Indigenous Science should be included in the School Science Curriculum. *Australian Science Teachers' Journal*, 48(2), 36 – 40.
- National Research Council, 2000, *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press, p.319.
- Odhiambo, T.R. (1967): East Africa: Science for Development. *Science*. p. 876 – 881.
- Ogbu, J.U. (1992): Understanding Cultural Diversity and Learning. *Educational Researcher*, 21(8). p.5 – 25
- Piaget, J., (1978), *Success and Understanding*: Cambridge, MA, Harvard University Press.
- Ritchie, S.M. (1994): Metaphor as a tool for Constructivist Science Teaching; *International Journal of Science Education*, 16 (3), p. 293 – 304.
- Rollnick, M. (1998): Relevance in Science and Technology Education. In Naidoo, P and Savage, M. (eds.), *African Science and Technology into the New Millennium Practice, Policy and Priorities*. Kenwyn, Juta and Co. Ltd. p. 96-140

- Scheerens, J. (2000): Improving School Effectiveness. *Fundamentals of Educational Planning*, No. 68, Paris UNESCO International Institute for Education Planning Publications. p.18 – 31.
- Swift, D. (1992). Indigenous Knowledge in the Service of Science and Technology in Developing Countries. *Studies in Science Education*, 20. p.1 – 28.
- Thomas, R.G. (1992). Cognitive Theory-based Teaching and Learning in Vocational Education. *Information Series* No. 349. Columbus: ERIC Clearing House Ed 345109.
- UNESCO (United Nations Education, Scientific and Cultural Organization) (1962). Conference of African States on the Development of Education in Africa: *Final Report*, 15-23 May, Addis Ababa. Paris: UNESCO.
- Vygotsky, L.S., 1978, *Mind in Society: The Development of the Higher Psychological Processes*: Cambridge, MA: Harvard University Press, p.159