FUNCTIONAL APPROACH TO THE TEACHING OF SCIENCE

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Abstract

The paper recognizes that the environment is replete with resources for the teaching of science. Science teachers should therefore avail themselves of this opportunity to teach science for functional understanding in an out-of-class environment. This paper demonstrates how science (as exemplified in integrated science) can be taught in an out-of-class learning environment by providing a glossary of some integrated science concepts and learners' out-of-class experiences. The concern in this paper is on how to improve the quality of science teaching in Nigeria so that all students can experience relevance and worthwhile scientific knowledge that will make a difference in their lives and the society. The underlying emphasis is to teach science so as to provide understanding based learning experiences that are connected with what goes on in the daily experiences of learners. Relevance can be established where a shift of instructional strategies is conceived by the teachers.

The technological development of any nation depends on the quality of her education which is dependent on the competence and professional qualification of the science teachers. Adequate knowledge of modern science is an uncompromising pre-requisite and sine-qua-non of advanced technological culture all over the world. Science no doubt is the key that unlocks the door to modern development. Perhaps this is why the government includes integrated science as one of the core subjects in primary, junior, senior secondary schools and tertiary institutions. It emphasizes inquiry into the nature of the environment. It supposes an approach to the study of the environment free of the limitation imposed by separate subject disciplines. Rutheford (as cited in Afuwape, 2006) sees integrated science as joining subjects into a single course in which the concepts of science are presented through a unified approach.

The environment is the habitat of resources needed in the teaching of science. In the words of Onifade (2005) "our environment represents the macro-laboratory and is richly endowed with resources for the teaching of science". Teachers of science therefore need to harness the opportunity provided by the abundance of out-of-class learning environment.

Out-of-class learning environment entails involving learners in experiences, questions and issues outside the classroom (Owolabi, 2006). Science is basically about becoming aware, exploring, understanding, and exercising some degree of control over the environment through senses and personal exploration (Erinosho, 2005). This implies that science teaching should enable learners acquire functional understanding of science, as science is being questioned for relevance of the subject matter to students' need.

It is a fact that there is a disjunction between the knowledge of learners in school science and their everyday experiences. A major factor responsible for this is poor methodological approaches Wandiga (as cited in Owolabi, 2006)). Science teachers have been reproached for adhering to the lecture method at the expense of innovative pedagogic methods that engage learners in actual doing. Teaching science by doing occurs mostly in the laboratory and learning within the school laboratory tends to be solitary and divorced from the real world. Consequently there is little link between concepts taught and the learner's out-of-class experiences. Functional understanding of science can hardly be achieved in an atmosphere devoid of out-of-class experiences. Functional understanding implies meaningful understanding of concepts taught. Relevance to learners' knowledge is as a result of his/her interacting and making sense of the environment in which he/she lives. It becomes incumbent on us as science teachers to find ways through which students may use their knowledge or views of the world, in ways that draws on their environment. Cajas (as cited in Owolabi, 2006) noted that meaningful application of science in relation to students' everyday life will reduce forgetfulness in students and also enhance their creativeness. To achieve this, it is imperative to revisit the pedagogical strategies currently in use in our classrooms. The task of science education today is adapting scientific concepts taught in school to every experience of students. Erinosho (2005) observed that out-of-class learning environment gives room for complete intellectual accomplishments which is yet to be fully integrated into the school science programme. This call for concerted research attention hence this paper demonstrates how science can be taught by using out-of-class learning experiences within the environment of the learners.

Need for Paradigm Shift in Science Teaching in Nigeria

The school's most important and expensive resource is the teacher. Of all the tasks which teachers should perform, dissemination of knowledge through teaching is a major function. The method used by teachers to a greater extent determines the level of achievements in learning. Adeyemi (1995) had noted that reports of communiqué of conferences had expressed complete dissatisfaction with the level of science teaching in Nigerian schools. Science is being taught as if it was an immutable body of knowledge or rhetoric's of conclusions. In realization of this gross defect in teaching, the science curriculum, which was developed in 1985, recommended that teachers should adopt the student-activity base approach.

Science is an activity-oriented discipline. Therefore, science teaching should be activity- driven where students are actively engaged throughout the lesson. Obanya (2003) observed that modern societies have developed the practice of directed learning which is not the same as dictating to the learner, but more of helping the learner to explore his or her own innate capacities for learning and continuous self-development. This can be realized if science teaching can reflect the everyday life experiences of the learner. It implies therefore that science teaching requires a pedagogical strategy that provides a shift in focus from content to process to reduce rote learning (memorization) of concepts, facts and promote experiential learning. Linking science learning with the environment of learners is based on the constructivism mode of learning which is about how individuals construct knowledge in a particular learning context through interplay between prior experiences and the environment. The prior experiences and the learner's environment provide the platform for cognition in science. This approach promotes the minds-on and hands-on learning skills, which have been identified as the heart of scientific teaching for creativeness (Erinosho, 2005).

Connecting Science Concepts to Out-of-Classroom Experiences

The connection of school science with students' everyday lives is an educational goal, which looks simple, plausible and desirable. However, this goal could be complex, and difficult if not treated with concern. As noted by Cajas (1999), teachers find it very difficult to connect school science with out-of-school experiences. He noted further that the problem of connecting school science with student's everyday life experiences is an epistemological problem. Perhaps science teachers do not have the kind of knowledge needed to help students with this task. The knowledge possessed by teachers can take several forms; they include content knowledge, pedagogical knowledge and pedagogical-content knowledge. The thrust of this paper is on pedagogical content knowledge. A glossary of integrated science concepts and real world experiences as exemplified in the Table will go a long way towards illustrating the issue of relevance of out-of-class teaching.

A glossary of out-of-classroom experiences which can be used to teach integrated science concepts is exemplified.

Integrated Science Concepts	**Out-of-classroom Experiences**
Matter	Matter is any substance which has mass and occupies space. Examples include wood, water, stone, metals, food, plants and animals. The teacher should take the students outside the classroom to measure the mass and space occupied by the itemized.
Centripetal Force	Centripetal force is a force which acts on a body moving in a circular path and is directed towards the center, around which the body is moving. It is the force that is necessary to keep an object moving in a curved path and that is directed inward toward the center of rotation. This is experienced when a stone is tied to a string and whirled round. Another example is merry-go-round.
Surface Tension	Surface tension is the force per unit length, tangential to the surface. The origin of surface tension can be explained by considering the action of molecular forces in fluids. Well below the surface of the liquid where the sphere of molecular attraction is entirely in the liquid. The molecules are equally attracted by other molecules around them. Near the surface, part of the sphere of attraction is in the air and part in the liquid. The attraction by the molecules downwards and sideways are much greater than that due to the molecules above (in vapour) which are fewer hence, there is a resultant attractive force towards the body of the liquid, and tension is created along the surface. Some examples include; 1. When water drips slowly from a water tap, the shape of each small drop is spherical. 2. When a paint brush is dipped into clean water the hairs spread out when the brush is removed, the hairs are pulled together by the forces of surface tension in the film between the hairs. 3. Soap bubbles have spherical shape 4. Mosquito larva hold on to water surface to breathe because the water has surface tension to support its

	weight.
1st class lever	Fulcrum between load and effort. Example observing a tailor at work with a pair of scissors.
2nd class lever	Load between the fulcrum and the effort. Example is a conveying Wheelbarrow.
3rd class lever	Effort applied between the fulcrum and the load. Examples are the seesaw, the biceps muscle and the forearm.
Doppler effect	The Doppler effect or Doppler shift is the change in frequencies (and wavelength) of light case by the relative motion of the source and the observer (as in the classical Doppler effect) when taking into account effects described by the special theory of relativity. Examples: (1) A source of light waves moving to the right, relative to observers with velocity 0.7c. The frequency is higher to observers on the right and lower for observers on the left. (2) The increase or decrease of a whistle of a train approaching and moving away from a station is as a result of Doppler Effect. (3) High pitch of a siren of an approaching ambulance drops suddenly as the ambulance passes by. This is called the Doppler effect.
Ultra sonic sound:	Sound below human hearing. Dogs can detect or hear ultrasonic sound, hence are able to detect sound when somebody tip-toes.
Capillarity	Absorption of water by a towel, rise of oil by a lamp wick.
Up-thrust	Causes an apparent loss in weight when an object is immersed in a liquid. Example is the lighter weight of a fetching bowl when immersed in water compared to the weight above water.
Mirage	This is an imaginary pool of water observed on a tarred road during hot weather. It occurs as a result of reflection.
Resonance	Vibration set-up when you walk along a plank used as a bridge over a gutter or ditch.
Conduction	When you place one end of an iron rod in a fire, the other end becomes hot as a result of conduction of heat through the iron.

Convection	This is the process in which heat moves through a gas or a liquid as the hotter part rises and the cooler heavier part sinks. Everyday examples: 1. Heating water on a stove: the upward movement of steam noticed when water boils, is as a result of convection. 2. A hot air balloon: hot air balloons rise due to the propensity of warmer air to be less dense than the air around it. A heat source at the bottom of the balloon heats the air molecules around the flame, and those molecules rise. Warmer air is less dense than cold air, so as the warm air rises the molecules spread out. The cold air is pushed downward, where it is also heated. The swirling movement of the warmer air as it rises continues to increase the temperature of the air around it. 3. Warm weather and bodies of water: Weather is largely affected by convection, as air creates breezes over land masses located next to large bodies of water like lakes or oceans. Water has a higher heat capacity than earth, so it holds its heat better. That means it also takes longer to change the water's temperature in either direction. At daytime, the air over the body of water will be a lower temperature than the air over land, creating a low pressure area over the land and a higher pressure area over the water.
Radiation	The term radiation refers to energy that travels through space or matter in the form of energetic waves or particles. When radiation occurs, the waves move out in all directions from the producer of the energy. Examples of everyday radiation: the sun reaches us on the earth by radiation. Visible light, infrared light, near ultraviolet light, microwaves, low frequency waves, radio waves, waves produced by mobile phones, campfire's 'heat thermal radiation, extremely low frequency waves (3 – 30 hz), very low frequency waves(3 – 30khz), power lines, strong magnets, light bulbs computer screens, radio frequency (Non-ionizing radiation), ultraviolet light, x-rays, gamma-rays, radioactive decay's particles, medical imaging equipment, sterilization of medical tools, nuclear power production, metal mining, coal mining, nuclear weapons, radiation therapy for specific form of cancer, nuclear medical scans, airport security scan
Gravitational Force	The earth has a gravitational pull (force) on every object

on and above it. Pick an object on the ground around the school compound, throw upwards and observe it fall back towards the ground.

Friction	Friction is a force which acts on the surface of the bodies in contact and tends to oppose the motion of body over the other. Examples walking, vehicles moving or stopping. Friction enables the conversion of mechanical energy to heat energy. Helps nails and bolts to stay tight.
Motion	Motion involves change of position of a body depending on time. Random Motion: A body moving in a zig-zag manner with no specific direction e.g. butterflies. Rectilinear Motion: Motion in a straight line e.g. light travelling from point A to point B in a straight line (rays of sunlight to the earth). Translation Motion: Motion in one direction e.g. a car moving in one direction from one town to another. Rotational motion: A body moving in a circle e.g. the wheels of a moving car rotating about its axes, rotating blades of an electric fan. Oscillatory Motion: A body moving to and fro about a fix point e.g. simple pendulum clock, stone tied on a string and made to swing to and fro.
Root Pressure	Water conducted through the root cells to the xylem is under pressure. This is due to the accumulation of water in the roots as a result of continuous absorption of water by the root hairs. The root pressure causes water to move across the root cells and up the xylem vessels to a certain height. To show root pressure cut the base of the stem of a potted plant and attach a long glass tube with a narrow bore. Water rises up to a height to several centimetres in the tube. The final height of water in the tube gives the maximum pressure that the cells of the root in the potted plant can exert. Root pressure is therefore one of the forces that contributes to the ascent of water up the xylem vessels in the stems.
Incomplete Metamorphosis	In some insect like the cockroach, grasshopper, locust, and dragon flies, the egg hatches into a miniature adult known as nymph. The nymph molts (ecdysis) at least about five times, increasing rapidly in size after each molt before the emergency of a fully grown adult or

imago. The stages between successive moults are called instars. This type of gradual growth and development during an insect life cycle (Pterygota) is known as incomplete metamorphosis. E.g. Scouting for grasshoppers egg on the field and observing first to fifth instars nymphal stages.

Complete metamorphosis Most insects, however, including mosquitoes, flies, butterflies, ants, bees and beetles, undergo complete metamorphosis. In this type of development, the egg hatches into lava which passes through a pupal stage before transformation into an adult insect. E.g. observe caterpillar (butterfly lava) on plants in a flower garden and make comparative studies of the larva, pupa and imago.

Turbidity Turbidity is caused by the presence of suspended matter in water. Clear water has low turbidity. Light can penetrate to a greater depth below the water surface in less turbid waters. This is important as it affects the distribution of photosynthetic organism in an aquatic ecosystem. By lowering a secchi disc into a drum of clear water and a drum of muddy water noting the depth at which the disk is no longer visible. The turbidity of the water in the two drums can be estimated.

Solution A solution ➔ is a homogenous mixture of two or more substances. The dissolved substance in the solution is called solute and the dissolving medium is called the solvent. Solute + Solvent =Solution e.g. a little salt or sugar into water in a glass cup stirred form a solution.

Suspension A suspension is a heterogeneous mixture of undissolved particles in a given medium. A solute is said to be in suspension in a liquid when small particles of it are contained in the liquid but not dissolved in it. The particles are usually large enough to be seen without the aid of the an instrument, and they settle to the bottom of the containing vessle if left undisturbed leaving the clear liquid above. Example, add some mud to a beaker of water, stir the mud in the water thoeroughly and then pour the resulting liquid in anotehr beaker. Observe this muddy liquid before allowing it to stand for about a day undistubed and observed.

Colloids A colloidal or false solution is an intermediate between a true solute and a suspension. In colloidal solutions in the individual solute particles are larger than the particles of the true solution but not large enough to be seen with the naked eye. E.g. fill a test-tube with starch solution stir and look at it carefully. Hold the test-tube of starch solution in a beam of light (direct sunlight or a beam of a torch) observe. Allow solution to stand for a day and observe; try to filter startch solution through a filter paper and observe. Examples of colloid solution are

Smoke and harmattan are example of colloida solution of solid (dust) in gas

Fog is an example of a colloidal state of liquid in gas (fine particles of water in air)

Acids

An acid is a substance which when dissolved in water produces hydrogen ions, H^+ as the only positive ion e.g. $HCI \rightleftharpoons H^+ + CI^-$. An acid can also be defined as a substances which in aqueous solution produces hydronium ion, H_3O^+ as the only positive ion e.g. $HCI_{(aq)} + H_2O_{(aq)} \longrightarrow H_3O^+_{(aq)} + CI^-_{(aq)}$. Acids are classified into organic and inorganic acids. The organic acids occur as natural products in plants and animals, while inorganic acids are prepared from inorganic matter. Some examples of organic acids are ethanoic acid from vinegar, tartaric acid from grapes, lactic acid from milk, citric acid from lime and lemon, amino acids from proteins, fatty acid from fats and oils and ascorbic acid (vit c) from oranges, while inorganic acids includes hydrochloric acid, HCI, trioxonitrate(V) acid, HNO_3, tetraoxophosphate (VI) acid, H_2SO_4.

Conclusion

The environments in which the learner lives in replete with materials that can be used to illustrated and illuminate scientific concepts taught. Meaningful teaching of science occurs when what is taught is related to the world of the learners. The use of science in everyday life should be emphasized. It is only by so doing that learners can develop creative thinking and apply knowledge acquired in novel situations. Curriculum development efforts should be geared towards relating scientific concepts to the daily experiences of the learners. A glossary of basic science concepts related to real world experiences in the curriculum could aid the teaching of abstract concepts.

References

Adeyemi, M.A. (1995). *Curriculum change and innovations: Impact on science curriculum projects*. Lagos: Deutchakz Publishers.

Afuwape, M.O. (2006).Understanding the Nature of Integrated Science. In U. Nzewi (Ed.), *Science Teachers Association of Nigeria, 47th Annual Conference Proceedings* (pp 223-227).Calabar: Gold Press.

Ajeyalemi, D.A. (2003).*Capacity building in the sciences; imperative for teacher education in Nigeria.* Inaugural lecture series, University of Lagos: Unilag press.

Erinosho, T.Y. (2005). A review of school science curricula for developmental needs of Nigeria. U.M.O. Ivowi (ed.). *Science and Technology Education for Development,* Yaba: NERDC Press.

Obanya, P.A.I. (2003). Functional education for liberating Africa. *Journal of the Nigerian Academy of Education,* 1(1), 21-29.

Onifade, A. (2005). The importance of improvisation and fabrication skills in science and technology education for development. U.M.O. Ivowi (Ed.), *Science and Technology Education for Development.* Lagos: NERDC Press.

Owolabi, T. (2006). Physics Teaching in an Out-Of-Class Learning Environment. In U. Nzewi (Ed.), *Science Teachers' Association of Nigeria 47th Annual Conference Proceedings* (pp. 294-297). Calabar: Gold Press.

Wandiga, S.O. (2000). *Science for Development.* Retrieved from https//www.uonbi.ac.ke/wandigas/