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Rich Environments for Active Learning and Science Learning in Nigeria

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Abstract

Science is part of human live and actions, despite its importance; there is crisis in learning science. Some of this problem can be traced to the emphasis of learning basic facts and definitions from text books as against the applications of knowledge in daily life or the development of higher order thinking. To implement a successful science education in Nigeria, there is need to help students transfer learning from one situation to another. Learners must be helped to see themselves as constructors of knowledge in a variety of forms; learning must be seen as a collaborative process; learners should be assisted to bring their own needs and experiences to a learning situation; they should be helped to acquire skills and knowledge within realistic contexts; and methods used for assessment must take more realistic and holistic forms. In order to meet the developmental challenges of Nigeria and developmental economies, science learning should be encouraged using REALS which have been shown to enhance the effective learning.

Keywords: Rich Environment, Active Learning, Generative Learning, Science Learning

Introduction

Science permeates the human lives and informs their actions, for example in Physics students learn how mirrors work, how glasses can aid one's vision and how heat is treated by various household materials (plates and utensils). Chemistry involves learning the principles of matter, like atoms, molecules and compounds. Students also learn many different ways substances are formed from the minutest variations within compounds. Water for drinking, the food eaten, the air being breath, the medicines taken when people are sick are all made from these atoms, molecules and compounds. Biology, the study of life, teaches why living things are the way they are, why they need what they need to survive, and how all living things are categorized (Horan, 2010).

Science and technology are closely associated with our lives, they are closely linked to aspects of society, and studies and developments in both of science and technology are essential for the overall progress of society. Scientific research comprises of a wide variety of fields ranging from the study of different branches of science to relatively advanced fields like space exploration, human genetics and cloning. Scientific study attempts to explore and understand the working of the physical world. It tries to analyze the occurrences in nature and

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gain knowledge about nature through experimentation. As scientific research aims at gaining knowledge of the complexities of nature, it is important for the progress of mankind, the seemingly impossible feats have been made possible, thanks to the scientific research (Oak, 2009).

Learning Science

Science is a process of investigation into the natural world and the knowledge generated through that process. This process of investigation is often referred to as the scientific method and it is a linear set of steps through which a scientist makes from observation through experimentation and to a conclusion Carpi & Egger (2003).

Carpi & Egger (2003) asserted that science is not a linear process - it doesn't have to start with an observation or a question, and it commonly does not even involve experiments. Instead, the scientific method is a much more dynamic and robust process. Scientists get their inspiration from the natural world, from reading what others have done, from talking to colleagues, or from experience. They further argued that: Science uses multiple types of research toward investigating phenomena, including experimentation, description, comparison, and modeling. Some scientific investigations employ one of these methods, but many involve multiple methods, or some studies may even have characteristics of more than one method. Results from one research study may lead in directions not originally anticipated, or even in multiple directions as different scientists pursue areas of interest to them.

Several researches have shown that there are some crises in science education. Weiss (1987), Tobin & Gallagher (1987), Gallagher (1989) and Humrich (1988) in Fraser, Tobin & Khale (1992) reported that most science curricula emphasize learning of basic facts and definitions from science textbooks and relatively little emphasis is placed on applications of knowledge in daily life or on the development of higher-order thinking skills. Even though many programs purport to be inquiry-based, most show little evidence of inquiry on the part of students and teachers (National Research Council, 1996). This is so despite the fact that we are in the age of technological application and advancement where business and industry are having problems employing graduates with necessary knowledge of science.

Tobin & Gallagher (1987) noted that the activity types which are most prevalent in high school science classes involve the teacher working with the class as a whole group. They noted in their research, that: Seatwork activities which allow students to work from the textbook and to undertake tasks from worksheets, the chalkboard and the textbook are common. However Small-group activities frequently do not occur and usually are confined to the data collecting components of laboratory activities. Despite bold rhetoric in school brochures and textbook forewords, science programs typically are not inquiry orientated, do not have a laboratory emphasis and do not excite the majority of students. Students learn science from textbooks and lectures, and the curriculum is focused by tests which emphasize rote learning of facts and procedures.

Tobin & Fraser (1987) reported that some exemplary science teachers however, focus on students' learning with understanding, use strategies to encourage students to engage in higher-level cognitive tasks and maintain a classroom environment conducive to learning. This shows that intensive investigations of teaching and learning environments can produce knowledge to guide practice, policy formulation and research. To be able to influence the quality of science learning in all classes, it is desirable to use 'learning Rich classroom', this will facilitate positive changes in science classrooms. The use of such a "Rich Environment" in learning science is the focus of this research article.

Rich Environments for Active Learning

Rich environments for active learning have been defined as comprehensive instructional systems that have the following elements:

• evolve from and are consistent with constructivist philosophies and theories;

• promote study and investigation within authentic (i.e., realistic, meaningful, relevant, complex, and information-rich) contexts;

• encourage the growth of student responsibility, initiative, decision making, and intentional learning;

• cultivate an atmosphere of knowledge building learning communities that utilize collaborative learning among students and teachers (Collins, 1995);

• utilize dynamic, interdisciplinary, generative learning activities that promote high level thinking processes (i.e., analysis, synthesis, problem solving, experimentation, creativity, and examination of topics from multiple perspectives) to help students integrate new,

Knowledge with old knowledge and thereby create rich and complex knowledge structures; and,

• assess student progress in content and learning-to-learn through realistic tasks and performances, (Dunlap & Grabinger, 1992, 1993; Grabinger & Dunlap, 1994a, 1994b):

There two major factors that show the characteristics of learning environments, these according to Hannafin (1992) are integration and comprehensiveness.

Integration is a process of "linking new knowledge to old and modifying and enriching existing Knowledge. Integration enhances the depth of learning to increase the number of access points to that information". Goldman et al. (1992), noted that "environments are meant to invite the kinds of thinking that help students develop general skills and attitudes that contribute to effective problem solving, plus acquiring specific concepts and principles that allow them to think effectively about particular domains".

The second defining characteristic, comprehensiveness, refers to the importance of placing learning in broad, realistic contexts rather than in decontextualized and compartmentalized contexts. REAL learning strategies can guide and mediate individual's learning and support the learner's decision making (Hannafin, 1992). Hannafin also asserted that themes are used to help organize learning around interdisciplinary contexts that focus on problem solving or projects that link concepts and knowledge to focused activities within the environment.

There are 5 majors attributes of REALS identified by Grabinger & Dunlap (1995), these are:

- REALs are students centered; students centered learning environments place major emphasis on developing intentional learning and lifelong learning skills.

- Students engage in generative learning activities, people who learn through active involvement and use tools to build an "increasingly rich implicit understanding of the world around them, Brow et al. in Grabinger & Dunlap (1995).

- Learning takes place within an authentic context. An authentic task activity or goal provide learning experience as realistic as possible, taking into consideration the age and maturation level of the students and environmental constraints such as safety and resource available

- The use of authentic assessment strategies to evaluate student's performance.

- The fifth characteristic of REALS is that a shift be made to focus on social practice, meaning and patterns " All cooperative learning methods share the idea that students work together to learn and are responsible for one another's learning as well as their own" Slavin (1991).

Another REAL strategy that has been very successful in the process of learning is reciprocal teaching. Reciprocal teaching according to Palincsar & Klenk (1992) is:

An instructional procedure that takes place in a collaborative learning group and features guided practice in the flexible application of four concrete strategies to the task of text comprehension: questioning, summarizing, clarifying, and predicting. The teacher and group of students take turns leading discussions regarding the content of the text they are jointly attempting to understand.

The success of reciprocal teaching and by extension REALS according to Collings, Brown & Holum (1991) include engaging students in activities that help them form a new conceptual model of the task of reading. They see reading as a process that involves reflection and prediction rather than just the recitation of words. They learn to make what they are reading relevant to their needs and to monitor their progress and strive for clarification.

It is strongly recommended that Nigerian Science teachers should employ reciprocal methods of teaching in the science class; this will greatly improve the success of science in Nigeria.

Another method of learning activities associated with REALs is generative learning; this requires that students "engage in argumentation and reflection as they try to use and refine their existing knowledge as they attempt to make sense of alternate points of view" (CTGV, 1993).

According to Grabinger & Dunlap (1995), generative learning requires a shift in the traditional roles of students and instructors, students become investigators, seekers and problem solvers. These methodology or approach is typical of methodology of teaching science. Teachers become facilitators and guides rather than presenters of knowledge. Grabinger & Dunlap (1995) noted that generative learning is one of the simple features of a REAL, it produce something of value. According to them it is probably the most exciting part of REAL because students work on projects and tasks that are relevant to them and their peers. It keeps students busy and happy or active while helping them construct and evolve their knowledge structures.

REALS and Constructivism:

The Foundation of REALs is Constructivism and REALs (which means, constructivist learning environments, information rich learning environments, interactive learning environments, or knowledge building learning communities) are not new to education according to Grabinger & Dunlap, (1995).

Since the times of Socrates (470-390 BC) problems and questions have been used to guide students to analyze and think about their environments (Coltrane, 1993). Rousseau prescribed using direct experience (Farnham-Diggory, 1992). Dewey (1910) proposed student-directed reforms and experiential learning. Bruner (1961) advocated discovery or inquiry learning around realistic problems. The idea of, practice, application, and apprenticeship, by which student learn have been in practice for many years. There has been renewed emphasis on the need to reform schools and teaching methods for sciences.

In order to implement a successful science education in Nigerian Schools there is need to base teaching of science on some new assumptions about the nature of thinking, learning, instruction and achievement, the adoption of these strategies creates learning environment. There is need to accept that "[… the mere accumulation of factual or declarative knowledge is not sufficient to support problem solving. In addition to factual or declarative knowledge, students must learn why, when, and how various skills and concepts are relevant." (CTGV, 1993, p. 79).

The Cognition and Technology Group at Vanderbilt (CTGV) noted some flaws in America Conventional approach to Schooling and teaching, (this is applicable to Nigerian educational system.) these flaws which lead to inert knowledge according to them are:

• There is a constant battle of breadth versus depth and breadth usually wins. Educators tend to fill students with facts and leave no time for dealing with topics in depth. For example students are expect to remember dates, formulae, algorithms, quotations, and whole poems, yet show little practical use for that knowledge despite the fact that it is known that students have difficulty transferring the knowledge. Robertson (1990) states that Students who rely on memorized algorithms for solving problems typically do not perform as well on transfer problems as do students who rely on an understanding of the underlying concepts.

• When practice is provided for students, they are given arbitrary, uninteresting, unrealistic problems to solve. The example of story problems in math is overused. There are also examples of unrealistic and oversimplified problems in the sciences, language arts, and social studies. Again, this is done in the mistaken belief that there must be an emphasize on decontextualized skills that are applicable everywhere. Yet, these unrealistic problems have no meaning to the students who then fail to find any contextual cues to relate to problems they may encounter in their lives.

• Students are treated passively for 12 to 16 years, rarely giving them the opportunity to take responsibility for their own learning, to explore ideas of their own choosing, to collaborate with one another or with teachers, or to make valuable contributions to the learning of others. They do not learn to take charge of their own learning nor do they learn the skills necessary to become life-long learners and daily problem solvers.

The intention of this research paper is to gain a broader understanding of the experiences of students in an active learning environment mediated by rich environment in a science classroom which can be applied to the Nigerian situation. In an attempt to improve science education in Nigeria, the Federal Government of NIGERIA UNDER HIS EXCELLENCY FORMER PRESIDENT OLESEGUN OBASANJO launched Project 931/NIR/100 on the 29TH OF SEPTEMBER 2005.

The major aim of the project was to achieve National Economic and Human Development of the Country Using Mathematics, Science and Technology Education and to contribute to the realization of the Vision 2020 which targets Nigeria ranking among the 20 largest economies in the year 2020 (Federal Ministry of Education, 2006).

The publication also noted that "The Government of Nigeria took two complementary initiatives: - Promoting Science and Technology Education for Primary & Secondary Schools and Colleges of Education in Nigeria, and the Reform of the Nigerian Science, Technology and Innovation System".

The initiatives were made to address the global vision of Transforming the Society as defined in the Nigerian Economic Empowerment and Development Strategy (NEEDS).

The Project Coordination & Implementation Committee also noted that as a "matter of fact, science has to play a leading role in transforming the present Nigerian society into an emerging knowledge society. In this regard, there is need to build learning communities all over the country, and in particular among the younger generations. Hence, improving the teaching of Mathematics, Science and Technology stands as a major tool in promoting quality human resources indispensable for sustainable development."

The assumptions about learning and teaching as made by Grabinger & Dunlop (1995) must be applied to teaching and learning in Nigerian schools, these include:

• Helping students transfer learning from one situation to another with difficulty. Learning is more likely to be transferred from complex and rich learning situations. Rich learning activities help students think deeply about content in relevant and realistic contexts (CTGV, 1993).

• Learners must be helped to see themselves as "constructors" of knowledge in a variety of forms. They take an active role in forming new understandings and are not just passive receptors.

• Science students must be helped to see learning as a collaborative process. Students learn not solely from experts and teachers, but also from each other. They test ideas with each other and help each other build elaborate and refined knowledge structures.

• Since learning is cognitive and involves the processing of information and the constant creation and evolution of knowledge structures. Students must focus on and make visible thinking and reasoning processes. This is not suggesting abandoning the teaching of content to teach only thinking and reasoning because "knowledge of concepts, theories, and principles-empowers people to think effectively" (Bransford et al., 1990, p. 115).

• Learners should be assisted to bring their own needs and experiences to a learning situation and are ready to act according to those needs. We must incorporate those needs and experiences into learning activities to help students take ownership and responsibility for their own learning.

• Students should be helped to acquire Skills and knowledge which is best acquired within realistic contexts. Morris, Bransford & Franks (1979) call this "transfer appropriate processing." Transfer appropriate processing means that students must have the opportunity to practice and learn the outcomes that are expected of them under realistic or authentic conditions.

• Assessment of students must take more realistic and holistic forms, utilizing projects and portfolios and de-emphasizing standardized testing. Educators are increasingly aware that conventional achievement and intelligence tests do not measure the ability of people to perform in everyday settings and adapt to new situations (CTGV, 1993).

Blakely & Spence (1990) also noted some instructional strategies that can be incorporated into classroom activities to help develop metacognitive behaviors. These strategies can also help in improving the effective learning of science in Nigeria classroom, the strategies include:

• Students should be asked to consciously identify what they "know" as opposed to "what they don't know."

• Students should keep journals or logs in which they reflect upon their learning processes, noting what works and what doesn't.

• Students should manage their own time and resources including estimating time required to complete tasks and activities, organizing materials and resources, and scheduling the procedures necessary to complete an activity.

• Students must participate in guided self-evaluation using individual conferences and checklists to help them focus on the thinking process.

Information Communication Technology and Science Learning

Science teaching in different levels of education in Nigeria is still done mainly by the old conservative approach. Aladejana (2007) noted that the use of Information Technology (ICT) and a new kind of Science (NKS) for science teaching and learning science were said to make science more meaningful and encourages active student's participation.

Sutton (2006) have shown that ICT can promote students intellectual qualities through high order thinking, problem solving, improved communication skills, deep understanding of learning tool and concepts being taught. Trinidad et al (2001) and Hawkings (2002) have also noted that the use of Information communication Technology can help in supportive, interactive teaching and learning environment. It can also create broader learning communities and provide learning tools for students, especially those of them with special learning needs. The use of computer graphics have been used to show different types of relationships, especially those dynamic processes that cannot be shown by pictures.

In his work on 'A New Kind of Science' (NKS) Stephen Wolfram's emphasized the use of Information Communication Technology (ICT) especially the use of Computers in learning and explaining concepts. In the work, wolfram noted that NKS is a concept consisting of over 800 programs that covers many computational functions and concepts. Wolfram discussed the connections and implications of his discoveries for subjects like mathematics, physics, biology, and computer science.

NKS has introduced a new paradigm for doing science; it is now used not only in science but also in technology, business, and the arts. According to Boquta (2004), NKS involves changing paradigms from the computational sciences to the science of computation. In reviewing the work of Wolfram New Kind of Science, Kadvany (2002) noted that the NKS book is a positive heuristic with key ideas for generating new models and problem solutions, predictions or explanation of novel facts, or novel explanation of existing known results. Its inventory of current successes is in solving existing problems or predicting, describing, or explaining existing natural phenomena.

Africa and indeed developing economies have enormous development challenges; therefore the scientific approach to problem solving must be promoted in all domains and at all levels in order to help address these problems. In doing this, Science must be used by man for the purpose of understanding his environment, himself and the universe, discovering and designing means of transforming resources for quality life improvement and sustainable livelihoods. Science must therefore be seen as a key factor to Peace, Progress and Humankind Advancement. This is why it is very important to ensure that science and technology learning should be taking with all seriousness. It is believed that REALs can enhance the effective learning of science in Nigeria. This is what this paper attempted to bring to light. It is only an implementation of a successful science learning program that can help Nigeria achieve her National Economic and Human development and the realization of the vision 2020 which is to make Nigeria rank among the 20 largest economies in the year 2020.

In conclusion, for Nigeria to achieve her developmental goals, science teachers must shift from the traditional way of teaching scientific facts, principles and rules to the teaching science process skills and encourage students to explore their environment using REALS. This view was also expressed by Amen–Anegbe (2009), who also emphasized need to re-think the instructional strategy in science education to ensure that there is a meaningful learning. Science teachers must devise ways of motivating students. The decline in the trend of students' choice of science subjects at the secondary school must be nipped in the bud if Nigeria will attain its full technological potential in a changing world.

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