



EFFECTIVE USE OF NIGERIAN JUNIOR SECONDARY SCHOOL LABORATORIES IN TEACHING STUDENTS INTEGRATED SCIENCE EDUCATION: THE NEED FOR AND USE OF DISCOVERY-INQUIRY STRATEGY

¹Gadzama, Bitrus Ijai & ²Adam Umar Abba

^{1&2}*School of Science Education Integrated Science Education Department
Federal College of Education (Technical) Potiskum
P. M.B. 1013 Yobe state*

Abstract

Science and Technology are the major factors in the development and industrialization of any nation. The Discovery-Inquiry strategy of Integrated Science Teaching has been identified as the popular strategy adopted by many nations around the world to revolutionize Integrated Science teaching and learning. This paper therefore, examines the need for readiness of our secondary school system to meet up with the challenges of Teaching Integrated Science Education by the implementation of Discovery-Inquiry strategy using the Laboratories in the face of our nations struggle to develop and become technologically self-reliant nation. Practical hints on how to effect such an instruction are given; conclusion and recommendations were also made.

Keywords: Laboratories, Teaching, Integrated science and Discovery-inquiry.

Background to the Study

Science and Technology have in many ways become the foundation of wealth and development of any nation around the world. Education in Science and Technology can therefore be seen as a most appropriate vehicle for the transformation of the individual and society as asserted by Nwosu and Nzewi (1998). This can be achieved when Science and Technology are appropriately and effectively taught to the students in our secondary schools.

Integrated Science Education serves as the Science course for the beginners in our Junior Secondary Schools and would therefore provide the students with the strong foundation and an important spring board for other science subjects. MAduabunam (1995) reported results obtained from the second International Science study (according to Rossier, 1998) in which different countries in the world participated in the competition. In which Nigeria pupils ranked last in the groups in primary school science and second to the last in junior secondary school science groups.

This report was very disheartening to all Nigerians and it suggested the poor state of affairs in our school science. Earlier studies by (Okebukola, 2004, Nwosu, 1991) have also indicated poor quality teaching of Integrated Science Education and poor academic performance of students in this subject. Therefore, the need for the use of appropriate and effective strategies for teaching Integrated Science Education to the students should be emphasized with much seriousness. This will help not only to demystify Integrated Science Education, but also make it more interesting and less fearsome.

Objectives of the Study

This paper examines the need for readiness of our secondary school system to meet up with the challenges of Teaching Integrated Science Education by the implementation of Discovery-Inquiry strategy using the Laboratories in the face of our nations struggle to develop and become technologically self-reliant nation

Literature Review

The world today is engulfed in the politics of Science and Technology to continue to maintain their leading role and control of the world politics and economy, while the developing nations need science and technology to break-off the shackles, of domination and exploitation of their economy by the industrialized nations.

This is reflected in the changing goals of Integrated Science Education in the various nations of the world. In pursuance of their objectives to revolutionize Integrated Science Education teaching and Science courses in general, so that, they could continue to be relevant in the world politics of Science and Technology. Many of the developed nations embarked on various Science projects to carry out researches and make recommendations on the best strategy to adopt in teaching Integrated Science effectively in their countries. so of these projects have given birth to such programmes as the Nuffield programme, the Biological Science curriculum programme, Chemistry and Integrated Science programmes where inclusive.

One thing is certain about this new Integrated Science Education programme, all this is aimed at teaching Integrated Science through Discovery-Inquiry strategy. According to Osobonye (2002) most of the government funded programmes for developing modern instructional strategies for the elementary and secondary schools over the last eighteen years have stressed students' involvement in Discovery-Inquiry oriented activities. What then is the Discovery-Inquiry strategy of teaching Integrated Science Education and why teach Integrated Science by this strategy?

Why Teach by Discovery-Inquiry Strategy?

Discovery-Inquiry occurs when an individual is mainly involved in using his/her mental process to mediate or discover some concepts or principle. According to Atadoga and Onaolapo (2008) for a student to make discoveries, he/she has to perform certain mental processes such as Observing, Classifying, Measuring Predicting, Describing, Inferring etc. Therefore, teaching Integrated Science Education by Discovery-Inquiry requires the teacher directing and guiding the students to make use of the above mental processes to assimilate concepts and principles of Integrated Science Education. While in inquiry, the individual tends to act more like a mature adult by making use of the discovery mental processes plus those characterizing mature adults such as formulating problems, formulating hypotheses, synthesizing knowledge, designing experiments and demonstrating such attitudes as objectivity, curiosity, open-mindedness and respect for theoretical models. By constantly making use of these mental processes students develop into mature scientists with broad spectrum of experiences serving as a foundation in their daily encounters into the mysteries of maturity (Osobonye, 20002 and Musa, 2000).

One can only develop Discovery-Inquiry thinking abilities only by being involved in the activities requiring the performance of the mental tasks described above. One of the basic psychological principles of learning states that, the greater the students involvement in

the learning process, the greater the learning takes place. The philosophical and psychological advantages of teaching Integrated Science Education using the Discovery-Inquiry strategy are many and have been discussed in detailed by Bruner (1961) who was instrumental in leading the movement towards inquiry teaching.

Atadoga and Onaolapo (2008) summarized the advantages on the following words. The strategy increase intellectual potency, shift from extrinsic to intrinsic rewards, help students learn how to learn in investigative way, increases memory retention, make instruction student-centre, thereby contributing better to a person's self concept, increase expectancy levels, develop multiple talents, avoid learning on the verbal level and allow more needed time for students to assimilate and accommodate the information.

The Role of the Laboratory in Discovery-Inquiry Learning

Modern Science Curriculum reforms seem to hold that, the major functions of the laboratory was to convey the strategy and spirit of science inquiry, to provide students with opportunities to investigate, to inquire and to find out things by themselves. It is contented that, the laboratory is the right place to go through scientific process to seek knowledge. It is the laboratory they put into practices those scientific skills and attitudes which we so much seek to develop in them to make them self-reliant in the future. Hence, Osobonye (2002) and Okoli (2006) pointed out that, laboratory are essential tool to the teaching of Integrated Science Education in our schools. According to him, students rely on the Laboratory as a place where they can both watch the teacher's demonstration as well as carryout practical activity-based work by themselves. Science to a large extent is experimental. Consequently, a Laboratory oriented approach is closer to the true nature of Integrated Science since it enables students learn what experimental scientists do and develop a rational approach to generating and answering questions. According to Voss (1992) and Okoli (2006), Laboratory experiences provide knowledge of specimen or phenomenon or illustrations of basic principles and their applications and serves as verifications of facts. Voss further viewed high quality Laboratory technical skills and students motivation is necessary to produce a well prepared group of scientists, engineers and citizens to make the scientific and environmental challenges of today and the future.

An Appraisal of Nigerian Junior Secondary School Laboratories

From the available research studies, it is evident that the importance of Discovery-Inquiry oriented, Laboratory investigations have not gained ground properly as a strategy of teaching Integrated Science Education in Nigerian secondary schools. A survey conducted by Osobonye (1988) involving integrated science teachers in secondary schools in Rivers state shows that, only 45.9% of the teachers have at least the minimum professional qualification required for teaching in secondary i.e. NCE.

While 95% of the teachers indicated that, they have Laboratories in their various schools, but only 35% of those sampled teachers indicated that, they have various facilities to perform the required experiments for their West African School certificate examination, and 30% admitted that, they use the discovery-inquiry strategy their teaching their science subjects. The results from the survey also revealed that student-teacher ratio is high. (above 40 per class) in the states secondary schools and teachers are overloaded with classes and other school responsibilities.

To worsen the situation, only 55% of the Integrated Science teachers have Laboratory assistants in their schools. Out of this proportion, 81.5% have just one Laboratory assistant attending to all the science Laboratories in the school. This sad and pitiable condition of our Integrated Science Laboratories is not peculiar to Rivers state only, nor can it be said to have improved since then. Bajah (1998) and Osobonye (2002) have independently observed and reported some of the deficiencies in our Laboratories in other parts of the country. According to Bajah (1998), the poor condition of our Laboratories is responsible for the degeneration of Integrated Science teaching in Nigerian secondary schools to simple story telling- what, according to him, in refined educational parlance

has been referred to as expository or “Talk and Chalk” Method of Teaching.

Need for the Use of Discovery-Inquiry in Integrated Science Education Curriculum
The dynamic and objective nature of integrated science and technology emphasize science and technology education through the use of Discovery-Inquiry. Finley (1983:48) described Discovery-inquiry as “a set of activities characterized by a problem solving approach” Learning through Discovery-inquiry implied that, students are most of the time placed in a problem situation and that, they are surrounded by a lot of appropriate and suitable materials with which they will explore their immediate environment to solve problems. The students that are carrying out inquiry are engaged in scientific processes such as Observing, Measuring, Questioning, Classifying and Control variables, Hypothesizing, Experimenting, Collecting and Analyzing data, Interpreting results, Formulating models and Defining operationally.

These processes are called science process inquiry skills and are used for inquiry process and best developed by actually carrying out an inquiry. A look at the contents of integrated science curriculum indicated that, its philosophy and objectives Discovery-inquiry oriented and advocated its use in Integrated Science Education are aimed at enabling the students who are exposed to integrated science instruction to acquire the science processing or inquiry skills enumerated earlier as well as continuity the process of inquiry when data do not conform to the predictions that was made. (Federal Ministry of Education, FME, 2004).

The significance of the inquiry process has been highlighted. Harlen (1987), Nwosu (1991), argued that the acquisition of this Discovery-inquiry skill enabled one to be autonomous and self actualized. It endows the individuals with the tools for learning, problem solving, analytical thinking and rational decision taking. Their acquisition and use which has been included as a major goal of integrated science and technology education also helps in the attainment of the desired scientific literacy needed for individual and societal growth and development. Also the use of Discovery-inquiry for Integrated Science instruction implies that, the Integrated Science teacher who is the critical factor in achieving the desired curricular objectives, now assumes the roles of a manager, mediator, facilitator, and assessor of learning rather than that of authority and sole possessor of knowledge.

Some Practical Hints on the Use of Discovery-Inquiry in Integrated Science Instruction: Using Discovery-Inquiry in Teaching Integrated Science is Vital and Imperative. Nwosu Ezewi (1998) Outlined the Following Practical Hints:

- (i) Teachers must have and use the Integrated Science Curriculum. This is very necessary since the teachers must know the curricular specific academic performance in observing the contents, activities and materials needed and specified in the curriculum.
- (ii) Use Discovery-inquiry from the first lesson: The first integrated science lesson to the beginners in JSS 1 students to the nature of science and how scientists do their work.
- (iii) The teacher should bring materials to the class. Students can help in the collection. Materials should include both living and non-living things. The lesson can also be an outdoor lesson, whatever is the case, the students can work individually and in homogenous groups (Gender and scores such as entrance examination scores can be used as the basis of grouping students should be encouraged to observe and manipulate materials and raise questions, formulate hypothesis, experiments etc. they can try to identify the living and non-living components of their environment, their structures, characteristics, functions etc. The teacher guides them in observing the materials given, classifying and measuring them. Let them experiment, record their observations in writing, graphs, charts etc. The use of any well written Integrated Science textbooks(s) can be of help.

- (iv) Continue the use of inquiry in subsequent instruction whenever it is required. The contents of the curriculum lend themselves very naturally to the use of inquiry. For example, under the first unit. You as A: Living thing students are to study the characteristics of living things-plants and animals including the students; structure of plants and animal cells etc. students SHOULD NOT BE TOLD what the characteristics of living things are or the structure of those things. Let them find out by themselves. Resources like the teachers table or students desks, stones, the wall of classroom etc. living thing like simple animals like snails, insects, plants (green and non green). Plants showing phototropism or seedling showing geotropism, animal's like hen/rabbit with young ones is a small pen, and with their food; students themselves and the teacher can be used.

Let students use these to find out the characteristics of living things and build their concepts of them. Let students use onion epidermis; their cheek cells to find out the structure of plant and animals cells using the microscope. The teacher helps them to bold up their concept of cell, cell types, similarities and differences etc.

- (v) Looking ahead/pre-lesson preparation: Lesson should be adequately prepared. It is not enough to write lesson notes. The required students' activities and the materials needed should be identified and adequately planned ahead of time. Having "LOOKING AHEAD" as the last sub-heading of each lesson plan/lesson plan for the work can help a lot.
- (vi) Here the teacher considers the activities and materials at the needed time. (e.g. Next week lesson) to enjoy and encourage improvisation: Improvisation is necessary for the implementation of inquiry based learning in Integrated Science. Teachers should learn to like to improvise and pass on the interest of enthusiasm to his/her students. This will also help to develop creativity in students apart from helping them to acquire desirable skills and attitudes.
- (vii) Add a tinge of innovation in the Display/Report of the products of the inquiry. For example, when using charts to explain the result of inquiry, one can incorporate appropriate questions into or use annotations. Colours can be added. Products of inquiry such as models can be placed on cardboard sheets and questions or explanation/relationship incorporated and annotated respectively.
- (viii) Incorporate co-operative learning and Discussion in inquiry any time it is possible and appropriate co-operative learning can help teachers get at the students more easily considering the large class-sizes prevalent in our schools today. Co-operative learning and Discussion can enrich the inquiry process and develop social skills among our students.

Conclusion

Considering the importance of the qualifications of teacher, and availability of laboratories facilities in the teaching and learning of the right skills and attitudes of Integrated Science teachers in the use of Laboratories. They should require the possession of adequate inquiry-based knowledge, skills and attitudes by the teachers as well as the availability of the appropriate resources including the reviewed copies of Integrated Science curriculum.

However, in this paper, it is advocated that each junior secondary schools in Nigeria and every Integrated Science teachers must have and used the Integrated Science curriculum. Since this contains the instructional objectives and appropriate activities to be carried out.

Teachers are also called upon to ensure adequately equipped with knowledge, skills and zeal needed for effective inquiry based lessons. Teachers' educators should use the curriculum in preparing these students. They should also ensure that the special method or strategy in the respective classes.

Conclusion

Considering the importance of the qualifications of teacher, and availability of laboratories facilities in the teaching and learning of the right skills and attitudes of Integrated Science teachers in the use of Laboratories. They should require the possession of adequate inquiry-based knowledge, skills and attitudes by the teachers as well as the availability of the appropriate resources including the reviewed copies of Integrated Science curriculum.

However, in this paper, it is advocated that each junior secondary schools in Nigeria and every Integrated Science teachers must have and used the Integrated Science curriculum. Since this contains the instructional objectives and appropriate activities to be carried out.

Teachers are also called upon to ensure adequately equipped with knowledge, skills and zeal needed for effective inquiry based lessons. Teachers' educators should use the curriculum in preparing these students. They should also ensure that the special method or strategy in the respective classes.

Recommendations

The following recommendations were made:

1. Majority of the teachers of Integrated Science Education in our secondary school are non professional graduates who know the “stuff” but have little or no knowledge of the strategies of Integrated Science teaching. This brand of teachers should acquire the knowledge of strategies of Integrated Science in order to teach effectively.
2. In service-training opportunities should be extended to such teachers to enable them professionalize in their job. Workshops and seminars should organized regularly for both qualified and unqualified teachers to improve their attitudes to Integrated Science Teaching with modern strategies of teaching Integrated Science and changes in Science Education system.
3. The bad global economy notwithstanding government should make fund, available for the purchase of Laboratories and maintenance of availability ones. Government should employ more Laboratory technologists/assistants to assist teachers that are using the laboratories.
4. It is timely to point out that, Laboratories teaching is time consuming Gadzama (2012), and it requires dedication and careful planning, for a positive result to be achieved. Therefore, school heads should consider the implication of this in the realization of the goals of Science Education in assigning responsibilities to the Integrated Science teachers in their schools.

References

- Atadogo, A. M. & Onaolapo, M. O. (2008), Handbook on Science Teaching Method volume one Shola printing press Sabon Gari-Zaria, Kaduna State.
- Bajah, S. T. (1998), Teaching Integrated Science Creativity Ibadan University Press, Nigeria.
- Brunner, J. (1961), “The Art of Discovery: Harvard Educational Review No. 31, P 52.
- Carin, A. A. & Sund, R. B. (1985), “Teaching Science through Discovery”. Columbus Ohio Avell & Howell Pp. 97 -99. Federal Ministry of Education (2004). National Policy on Education: Government Press Lagos.
- Finley, F. N. (1983), Science Processes, Journal of Research in Science Teaching 20(1), 47-54.

- Gadzama, B. I. (2012), "Effects of Science Process Skills Approach on Academic Performance in & Attitude among Integrated Science Students with Varied Abilities, M. Ed Thesis to Faculty of Education, Science Education Dept. ABU Zaria.
- Harlen, W. (1987), "Primary Science Teacher Training for Process-Based Learning (Report of the workshop held in Barbadoes 31st August 9th Sept London Commonwealth Secretariat & UNESCO.
- Moduabuman (1995), "Towards Effectiveness in Nigerian Secondary Science classroom: A need for increased utilization of Instructions time". Paper presented at National Conference on Effective Teaching: The Nigeria prospective at Nnamdi Azikiw University Awka.
- Musa, B. (2000), "The Reflective Effectiveness of Laboratory Teaching Methods for Enhancing Academic performance in chemistry among SSS III Students Unpublished M. Ed thesis to the Faculty of Education" ABU Zaria.
- Nwosu, A. A. (1991), "The Effect of Teacher Sensitization on the Acquisition of Science Process Skills among SS 1 Biology Students". An unpublished PhD Thesis University of Nigeria, Nsukka.
- Nwosu, A. A. & Nzewi, U. M. (1998), "Effective Communication of Integrated Science to Learners: The need for the use of inquiry method: STAN 39th Annual Conference proceeding". Heinman Educational Books, Ibadan, Nigeria.
- Okebukola, A. O. (2004), "Effect of Co-operative & Competitive Learning Strategies in Academic Achievement of students in Physics". Journal of Research in Education. 19(1), 71-75.
- Okoli, J. N. (2006), Effects of Investigative Laboratory Approach & Expository Method of Acquisition of Science Process Skills in Biology Students of Different levels of Scientific Literature". Journal of STAN 41 (1 & 2).
- Osobonye, G. T. (1988), Analysis of some Factors Affecting Laboratory Teaching of Science in Secondary Schools in Bonny LGA of Rivers State PGDE Thesis (Unpublished).
- Osobonye, G. T. (2002) "Nigerian Secondary School Laboratories & the Goals of Science Education: An Appraisal STAN proceedings of the 43rd Annual Conference Inaugural Conference of CASTME Africa". Heinman Educational Books Ibadan Nigeria.
- Tamir, P. & Lurretta, V.N. (1991), Inquiry Related Tasks in High School Science Laboratory Hand Book of Science Education 65(5).
- Voss, B. E. (1992), "Role of the Laboratory in College Science" Journal of College Science Teaching