

EFFECTS OF ETHNOSCIENCE AND TRADITIONAL LABORATORY PRACTICAL ON SCIENCE PROCESS SKILLS ACQUISITION OF SECONDARY SCHOOL BIOLOGY STUDENTS IN NIGERIA

Ebere Ibe

University of Nigeria, Nsukka

Department of Science Education, Faculty of Education, University of Nigeria, Nsukka

Appolonia A. Nwosu

University of Nigeria, Nsukka

Department of Science Education, Faculty of Education, University of Nigeria, Nsukka

Abstract: *The study investigated the effects of ethnoscience-based and traditional laboratory practical teaching strategies on science process skills acquisition of secondary school Biology students in Nigeria. Quasi-experiment of non-equivalent control group design was used. Three coeducational schools out of seventeen of such in Nsukka local government area of Enugu State, Nigeria were purposively selected. An intact class in each of the three schools was assigned randomly to 2 experimental groups taught using ethnoscience and traditional laboratory practical and a control group taught using expository. One hundred and fifty Senior Secondary two students formed the sample. Twenty item Test Of Science Process Skills Acquisition validated by experts in Science Education was the instrument for data collection. Research questions were answered using Mean and Standard Deviation. Analysis of Covariance was used for testing hypotheses. Findings reveal that ethnoscience-based students performed better than traditional practical group. It was recommended that teachers should provide instructional activities from students' environment. That will challenge them to be actively involved in classroom.*

Key words: Ethnoscience, Traditional laboratory practical and Science Process Skills.

Introduction

Science and technology remains an indispensable and inseparable tool for national development. If science and technology education is planned and implemented properly, a nation can experience breakthroughs in almost all endeavors of life. Any nation that neglects the teaching and learning of science in her schools does so at the risk of remaining underdeveloped. It is not surprising therefore that the Nigerian government sees science and technology education as instrument par excellence for national redress and socio-economic development which are needed for self-reliance. In Nigeria following her endorsement of international protocols on Education for All (EFA) and the Millennium Development Goals (MDGs) and their subsequent translation and adoption as National Economic Empowerment and Development Strategies (NEEDS) goals, it became imperative to update existing school

curricula of the nation to cater for dynamic global changes. To this end, school curricula in all subjects including the senior secondary school Biology curriculum were reviewed, restructured and distributed to schools in 2008. These curricula pay particular attention to the achievement of the Millennium Development Goals and the critical elements of the National Economic Empowerment and Development Strategies (NEEDS). Since the curriculum represents the total experiences to which all learners must be exposed; the contents, performance objectives, activities for both teachers and learners, teaching and learning materials and evaluation guide are provided. The prescriptions represent the minimum content to be taught in the schools in order to achieve the objectives of the new secondary school programme. However teachers are encouraged to enrich the contents with relevant materials and information from their immediate environment, but adapting the curriculum to their needs and aspirations.

The biology curriculum was adapted and revised from 1985 edition developed by Comparative Education Study and Adaptation Centre (CESAC). The federal government of Nigeria stated as one of the national goals that education should be channeled towards helping the learner in the acquisition of appropriate skills, abilities and competencies both mental and physical as equipment for the individual to live in and contribute to the development of the society (FRN, 2004). The objectives of the biology curriculum derived from the above national goal are to prepare students to acquire:

- Adequate laboratory and field skills in biology;
- Meaningful and relevant knowledge in biology
- Ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture
- Reasonable and functional scientific attitude.

In pursuance of the stated objectives, the contents and context of the biology curriculum emphasizes field studies, laboratory techniques, conceptual thinking and science process skills acquisition (NERDC, 2008). *****

- The acquisition of science process skills is the basis for scientific inquiry and development of intellectual skills and attitudes that are needed to learn concepts. Science process skills are the abilities, potentials, technical know-how which can be developed by experience and are used in carrying out mental operations and physical actions (Ibe and Nwosu, 2004). Nwosu and Okeke as cited by Akinyemi and Folashade (2010) described science process skills as tools needed for effective study of science and technology, problem solving, individual and societal development. These skills have the enduring quality that will contribute to students' abilities to answer questions and solve problems even when the information base of science and technology changes. The acquisition of the science process skills will help the learner to explore his environment and solve challenging problems identified in the environment. The skills are considered significant because:

- They contribute to the overall development of the individual.

- They have an enduring quality that will contribute to the individual's ability to answer questions and solve problems even when the information base of science and technology changes.
- The understanding and use of the process skills contributes to the students' abilities to solve problems in non science disciplines such Arts and Humanities.

The science process skills as identified by American Association for Advancement in Science (AAAS) are fifteen in number namely observing , measuring, classifying , communicating, predicting, inferring, using number, using space/time relationship, questioning, defining operationally , formulating models, hypothesizing, designing experiment and interpreting data. These science process skills can be inculcated in the learner using activity oriented and hands-on-minds-on teaching strategies (Odo, 2013). Some of these teaching strategies as highlighted in the literature are guided inquiry, constructivism, laboratory and ethnosience strategies. Some studies identified them as innovative teaching strategies that have the ability of enhancing students' performances in the science subjects at various levels of the learners science education as well as equipping him or her with skills for solving real life problems in the world in which he or she lives. Education for the future should be the type that will equip the individual with the power to adapt to changes in the environment.

Ethnosience can assist biology students in exploring the differences between their culture and biology. By this students are able to make sense of what they are learning, both in context of culture and school biology (Estrin, 1995). Neglect of the background and activities of learners and failure of science (biology) teachers to consider cultural resources and make use of them while teaching science (biology) is one of the main reasons for the alienation of the learner from sciences ((Igbokwe, 2010). Students seem to find it difficult to see meaning in the learning of science (biology), which they perceive as foreign culture quite different from their indigenous culture, especially as many science teachers in Nigeria are not equipped to teach it from cultural perspectives of the learners. To arrest the trend, science teaching (especially biology whose instructional materials are readily available in nature) must incorporate cultural learning environment vis a vis use of ethnosience strategy. That will produce functional secondary school graduates who could effectively exploit their environment by identifying the relationship between the science they learn and their cultural environment and experiences.

Abonyi (2012) defines ethnosience as the knowledge that deals with local perception, practices, skills and ideas and their underlying cosmologies in the context of processes of socio-economic development. In socio-economic development of a nation, the universality of scientific concepts, attitudes and skills is not indoubt. It will make more meaning if relevant examples are drawn from the learner's immediate environment. Barber (2012) lamented that the richly specialized science knowledge woven into the lifestyle of native students often goes on recognized by teachers. There is therefore the likelihood of students missing out on critical opportunities to build bridges between their life experiences and classroom science. This situation results from failure or inability of teachers to identify, explore and exploit the interconnectedness of indeginous and modern science and

concentrating on cook book traditional laboratory activities while teaching science for process skills acquisition. The researchers therefore consider it necessary to investigate the effects of ethnoscience and traditional laboratory teaching strategies on science process skills acquisition of secondary two (SS2) Biology students. The study will also look into gender as a factor of variability among students to see if such factor can influence acquisition of science process skills of observing, classifying, measuring, formulating hypothesis experimenting and inferring.

Literature review and theoretical framework

Laboratory work has been considered indispensable to learning in science. Freedman (2001) found that students who had regular laboratory instructions acquired significantly more scientific knowledge than students who had no laboratory instructions. According to Tobin (1990) laboratory practical is a way of allowing students to learn with understanding, and at the same time engage in a process of constructing knowledge by doing science. Mamlok-Naaman and Barnea (2012) found out that laboratory practical activities have potentials for students in fostering meaningful learning, inquiry, identifying problems, designing investigations and doing quantitative measurement rather than following a 'recipe' provided by the teacher as seen in Nigerian traditional laboratory practical activity classes.

In the traditional laboratory practical teaching strategy, learners are accustomed to concepts, rules and generalization given them that they lack the initiative to engage in meaningful inquiry. Students see no connection between asking questions and discovering cause-effect relationships. However, not all educators agree that cookbook laboratory practical strategy is an effective component of science teaching (Hofstein and Lunetta, 2004). "Cookbook laboratory exercise has been criticized for focusing on procedures and information verification (hands-on) only, leaving off cognitive engagement (minds-on) in learning process (Hart, Mulhall, Berry & Gunstone, 2000). This traditional form of laboratory experience may not contribute significantly to major aims of science education such as enhancing science process skills acquisition.

Providing students with opportunities for interaction and reflection on instructional materials from the students immediate environment/ surroundings can lead to more meaningful learning. Literature suggests that learning is an active and dynamic process through which learners personally define learning tasks and apply their prior knowledge and learning abilities in performing new tasks (Ibe and Nwosu, 2003). For effective learning to occur, Fafunwa as cited in Ugwuanyi (2014) stated that Nigerian society is in an ambivalent position and so is the child from this environment. Fafunwa explained further that the Nigerian children who are wholly brought up in a traditional environment leave the home for school and thereby entering into another educational system quite different and strange from the one they were brought up in and are accustomed to. Any assumption that he or she could easily adjust to such a dramatic and drastic change without creating a suitable link between the local environment and school science is bound to fail. For the child to accept and adapt to a new field of knowledge, the gap between his or her culture and the new field of knowledge has to

be bridged. It is on this note that researchers (Douglas, 1991; Davidson, 1998 and Atran, 2007) stressed that the poor achievement in science and acquisition of science process skills among Nigerian students are as a result of the wide gap that exist between their culture and the scientific field of knowledge. Davidson (1998) had suggested that the introduction and infusion of the culture of the learner into the science curriculum and proper utilization of ethnoscientific paradigms during instructional process may improve students' performance and interest in biology. It is on this note that the present study is conceived.

In the study of cultural values and perception of science and technology, James (2006) stated that appropriate alternative approaches to biology education and practice can have a positive effect on student's achievement, process skills acquisition and interest. One of such approaches that relates to the culture, the environment and lifestyle of the learner is ethnoscience. According to Abonyi (1999) ethnoscience refers to the materials, ideas and beliefs from the African environment and technology. Ogunbunmi and Olaitan (1988) defined ethnoscience as the study which reflects and approximates the natives own thinking about how their physical world is to be classified.

Utilization of ethnoscientific paradigms in instructional process is based on Piaget's theory of learning which emphasizes active involvement of the learner in the learning process. This study provides support for direct manipulation of concrete objects from learners environment as important element/ tool in learning development, conceptual and science process skills acquisition. This study strongly supports evidences from research (Okebukola, 2002) that biology practicals are organized as 'operation' during which the students watch the teacher perform indicated activities, develop techniques or even formula and other requirement which the WAEC syllabus has specified and which were called for on previous practicals. Most students' time is spent virtually recalling the equipment and materials used in previous practicals; rehearsing the experiment and their expected results and developing abilities in copying procedures, writing up the techniques to an extent that during examination time, the students in a simple stimulus-Response (S – R) theory/pattern, repeat them in expected fashion or manner. For such level of memorization and rote learning to still persist in our schools is a serious cause of worry and a big challenge to biology educators who are desirous that all students (both males and females) equally should develop functional science learning skills to ensure active participation in societal development. The study is therefore set out to investigate the effects of ethnoscience and traditional laboratory practical on science process skills acquisition among secondary school biology students in Igboland.

Statement of the Problem

For any nation to advance in science and technology, her science education /learning should produce individuals that are capable of solving their problems as well as those of the society. Such individuals are expected to be confident and self reliant, because of acquisition of Science process skills which are needed in learning how to learn the underlying principles, concepts theories, facts and laws of science. It therefore becomes necessary to train and equip the individual to make intelligent choices and personal decisions about his or her progress in a rapidly changing world including Nigeria. Science properly integrated in the

school programs and taught using appropriate strategies has a lot to contribute towards inculcation of the life coping skills in the learners.

The biology curriculum for secondary schools in Nigeria has been restructured, redesigned and re-aligned to reflect the use of instructional materials from the learners immediate environment. Our national biology core curriculum is learner centered and encourages teachers to use instructional materials from learners' immediate surroundings. There is therefore the need of exploring the effects of an innovative strategy of ethnosience and traditional laboratory practical on science process skills acquisition of SS2 biology students in Nigeria.

However, it has been observed that the biology teachers that use the curriculum talk and discuss biology to the students, relying heavily on textbooks /printed materials instead of doing biology in a manner that engages hands and minds on activities by the students. One would have expected that the extent to which teachers have relied on the conventional (expository) strategy, the resources that have so far been invested in the teaching-learning process and the confidence teachers express on the strategy, would have enhanced effective scientific innovations, facilitated science process skills acquisition and raised students achievement index; yet these have been impossible. The present study is therefore set out to determine the effects of ethnosience and traditional laboratory practical strategies on students' science process skills acquisition.

Purpose of the Study

The general purpose of the study was to determine the effects of ethnosience and traditional laboratory practical teaching strategies on acquisition of science process skills among SS2 biology secondary school students Nigeria. The study specifically investigated:

- Students level of acquisition of science process skills due to the strategies of science teaching chosen.
- If significant difference exists in acquisition of science process skills between males and females when taught by ethnosience, traditional laboratory practical and the expository strategies.
- The extent the teaching strategies interact with gender to affect students acquisition of science process skills.

Research Questions:

Two research questions guided the study:

- (1) To what extent do ethnosience based instruction compare with traditional laboratory practical strategy in affecting SS2 biology students acquisition of science process skills.
- (2) What is the influence of gender on science process skills acquisition of students exposed to the instructional strategies.

Hypotheses:

Three null hypotheses were formulated and tested at 0.05 level of significant.

H₀₁: There is no significant difference between the mean scores of students taught biology using ethnoscience and those taught using the traditional laboratory practical and expository.

H₀₂: There is no significant difference in the mean performance of boys and girls when exposed to each of the three strategies under investigation.

H₀₃: The interaction effect between teaching methods and gender of the subjects is not significant.

Research design and procedure

Quasi- experiment of the non equivalent control group design was used. The design was considered appropriate because intact classes were used to avoid disruption of normal classes. The sample was made up of 150 students from 3 intact classes selected through purposive sampling of 3 schools out of 17 co-educational schools in Nsukka Local Government Area of Enugu State, Nigeria. The 3 schools were randomly assigned to two experimental groups, namely, Ethnoscience and Traditional laboratory practical group and control group. Instrument for data collection was Test of Science Process skills Acquisition (TOSPSA) that had 20 items distributed among the 6 science process skills investigated namely observing, classifying, measuring, formulating hypothesis, experimenting and inferring. The TOSPSA was validated by experts in the Department of Science Education, University of Nigeria, Nsukka. Trial testing was done using 50 students in SS2 in a school outside of the study area. The reliability was established using test retest method. The reliability obtained were 0.791 coefficients for part A and 0.790 for part B. The normal class teachers who were trained by the researchers were given lesson notes and advised to adhere strictly to the lesson notes. The instructional packages for the 3 instructional strategies were the same except in approach of instruction.

Results

Results are presented in tables according to research questions and hypotheses.

Table 1: Mean and Standard deviations of scores of students' acquisition of science process skills by treatment.

	Pretest		Posttest		Gain Score
	Mean	SD	Mean	SD	
Group 1: Ethnoscience based strategy (All)	15.10	4.68	35.42	10.84	20.32
Group 2: Traditional Laboratory practical strategy (All)	15.18	3.35	26.22	7.96	11.04
Control group: Expository strategy (All)	14.28	4.03	21.84	6.59	7.56

In table 1 above, the posttest mean score of the students taught using ethnoscience was 35.42 over the group taught by traditional laboratory practical that had a mean score of 26.22. The

ethnoscience group had a gain score of 20.32 over the traditional laboratory practical group who had a gain score of 11.04. The expository group had the least mean score of 21.84.

Table 2: Mean and standard deviation scores of students' acquisition of science process skills by gender

	Pretest			Protest		Gain Score
	Gender	Mean	SD	Mean	SD	
Group 1:	Male	15.64	4.59	38.32	12.50	22.68
	Female	14.56	4.80	32.52	8.78	17.96
Group 2:	Male	15.96	3.52	27.04	9.15	11.08
	Female	14.40	3.06	25.40	6.65	11.00
Control group 3:	Male	14.76	4.11	21.48	7.63	6.72
	Female	13.18	3.98	22.20	5.48	8.40

From table 2 above, the mean gains for each group are as follows: In the ethnoscience group the males had a gain score of 22.68 while the females had 17.96. The slight difference in favour of males although shown as not significant in the ANCOVA table3 may be attributed to gender stereotyping prevalent in Nigeria. In the traditional laboratory practical group, the males had a gain score of 11.08 while females recorded 11.00. In the expository the females had a gain score of 8.40 while the males had 6.72.

Hypotheses

Data for testing the hypotheses are presented in table 3.

ANCOVA of students acquisition of science process skills by treatment and by gender.

Table 3: Source of Variation

Source of Variation	Sum of Square	Degree of Freedom	Mean of Square	F	Sign of decision F
Covariates	2554.766	1	2554.776	42.712	.00 Sig
Pretest	2554.766	1	2554.766	42.712	.00
Mean effects	4408.368	3	1469.546	24.567	.00
Treatment	4368.955	2	2184.478	36.521	.00
Gender	48.084	1	48.084	.0804	.37.Ns
2-Way Interaction	273.006		136.503	2.282	.10
Treatment x Gender	273.139	2	136.503	2.282	.10
Explained	7236.139	6	1206.023	20.163	.00
Residual	8553.354	143	59.814		
Total	15789.439	149	105.970		

Table 3 reveal that teaching strategies as the main effects is significant on students science process skills acquisition in biology ($f=.00$). Therefore at .05 level, significant difference

exist in the mean acquisition of science process skill score using ethnoscience and those taught using traditional laboratory practical and expository strategies. Null hypotheses 1 of no difference is rejected.

The table 3 also reveals that .05 is less than the probability level of .37 for gender. Gender therefore has no significant effect on students' science process skills acquisition. Hypothesis 2 is then accepted. For hypotheses three, the table 3 above reveal that there is no significant interaction effect between teaching strategies and gender on students science process skills acquisition.

Table 4: Multiple Classification Analysis

		Unadjusted mean	Adjusted +60d+Bet	Multiple R	R ²
Treatment	Ethnoscience	50	7.59	.37	.44
	Traditional Lab. Practical	50	-1.61	-1.90	.66
	Expository	50	-5.99	-5.46	
Gender	Male	75	1.121	.57	
	Female	75	1.121	-.57	

Table 4 above shows that the 3 levels of treatment had means of 7.59, -1.61 and -5.99 expressed as deviations from grand mean respectively. Since the deviation mean of ethnoscience group is higher than traditional laboratory practical group and the expository group, any variation in students' acquisition of science process skills is due to the ethnoscience strategy which was about 44%.

Discussion of Findings and Educational Implications

The findings for research question 1 which compare acquisition of science process skills of students taught by the three different teaching strategies are shown in tables 1 and 4. Data in table 1 show that ethnoscience group students had higher mean science process skills acquisition score followed by traditional laboratory practical group while the expository group had the least mean score. Table 4 show the 3 levels of treatment means respectively and expressed as deviation from the grand mean. Since the deviation for ethnoscience strategy was higher than those of traditional laboratory practical and expository, any variation in science process skills acquisition was due to teaching strategy (ethnoscience). This shows that the method of instruction helped the students to acquire the necessary science process skills better. The active involvement of the learner in the learning process as a result of the prior knowledge gained from the immediate environment gave rise to efficient learning. Piaget's theory focus on learners interaction with his world and solving problems personally. The knowledge that is gained from such interactions is not imitated but actively constructed by the learner with the teacher only acting as a facilitator of learning. The implication of this theory for teacher and biology students is that since the thought pattern of learners develop gradually in a logical manner and as a result learners cannot gain some scientific cognitive and physical skills when teaching and learning experiences fail to bridge the gap between the learners culture and the new field of knowledge. Teachers should therefore provide opportunities for interaction and reflection on instructional materials from the students

culture/environment. This would challenge students to engage in hands on and minds on activities in the learning process. This will in turn improve students psychomotor, computational and critical thinking skills as well as instilling in the students the spirit of cooperation for community development. The finding is also in agreement with Atran (2007) who found out that students' interaction with their environment as they construct reality by linking culture to advance biological knowledge make sense of what they are learning and acquisition of problem solving skills.

In table 2, the slight differences in both the mean and mean gain scores between the males and females in the Ethnoscience strategy though reported not significant by the ANCOVA table3 may be attributed to gender stereotyping and socialization process in Nigeria where males are culturally regarded as superior to females and are assigned to roles at home that are superior. This finding is in support of Okeke (2007) that gender differences in Science Technology and Mathematics achievement persist in Nigeria. However, Nworgu (2004) found out that gender differences in achievement in science is declining. The findings also agree with Nwosu (2001) that there is no significant difference in the means scores of students Science process skills acquisition due to gender and that slight difference that do exist could be caused by gender stereotype and socialization process which could come from home or outside the home. The result also indicated that interaction effect between teaching method and gender of subjects on Science process skills acquisitions is not significant. The finding is in agreement with Ibe (2013) that there is no significant interaction between instructional methods and gender on science performance. Ethnoscience teaching strategy maintained its superiority over traditional laboratory practical and expository. This implies that strong relationship exists between teaching strategy and science process skills acquisition. Teachers should therefore practice and use ethnoscientific paradigms during teaching and learning experiences.

Conclusion

Since Science process skills were better acquired using ethnoscience strategy, education stake holders especially the teacher should utilize the information and involve the learner actively in the teaching and learning process through adequate use of ethnoscientific paradigms.

Recommendations

Teachers should provide instructional activities from learners background/cultural environment that will challenge students to use hands-on-minds-on learning process.

The use of ethnoscience strategy will improve students' psychomotor, computational, and critical thinking skills and encourage cooperative learning.

In-service and pre-service teachers' workshops and conferences should be organized by government to train teachers on the use of ethnoscience based instruction.

Curriculum planners should pay attention to integrating instructional material from local environment of the learner in curriculum development.

Highlights:

- Ethnoscience group students had higher mean science process skills acquisition score.
- There is no significant difference in the means scores of students Science process skills acquisition due to gender
- Interaction effect between teaching method and gender of subjects on Science process skills acquisitions is not significant.

References

- Abonyi, O. S. (1999) Effect of an ethnoscience based instructional model on students' conception of scientific phenomena and interest in science. *Unpublished Ph.D thesis*, Dept of Science Education, University of Nigeria, Nsukka.
- *Atrans, S. (2007). Cultural mosaics and mental models of nature. *National Accounting of Sciences*, 104 (35) 13368-13374
- Davidson, D.M. and Muller, K.W.(1995). An Ethnoscience approach to curriculum issues for American, Indian students school science and mathematics. 98, 260-265.
- Douglas, M. (1991). *Implicit meanings: Essays in Anthropology*, New York: Routledge.
- Estrin, E.T (1995). Bringing Native American perspectives to mathematics and Science teaching. *Theory into practice* 34, 179 - 185
- Federal Republic of Nigeria,(2004) *National Policy on Education*. Abuja: NERDC Press.
- Hart,C., Mullhall, P., Berry, A., & Gunstone, R. (2000). What is the purpose of this experiment? Or can students learn something from doing experiment? *Journal of Research in ScienceTeaching*.37 (7),26-43.
- Hofstein, A. and Lunetta, V. (2004).The laboratory in Science Education: Foundations for the 21st century. *Science Education* 88 (1) 28-54. Doi:10.10002/sc.10106
- James, K. (2006). Identify, cultural values and American Indians Perceptions of Science and technology. *American Indian Culture and Research Journal* 30 93) 45-55
- Ibe,Ebere and Nwosu, A.A (2003) Effects of Guided-Inquiry and Demonstration on Science Process Skills Acquisition among Secondary School Biology Students. *Journal of Science Teachers' Association of Nigeria*, 38,(1&2) 58-63
- Ibe, Ebere (2013). Effects of constructivist model of instruction on scientific literacy levels and interest in science of Upper Basic Science students. *Unpublished Ph.D thesis*.Faculty of Education, University of Nigeria, Nsukka.
- Igbokwe, C. D. (2010). The effects of multicultural learning environment on cognitive achievement of pupils in primary science. *Journal of Science Teachers Association of Nigeria* 45 (1 & 2) 9 -19.
- Mamlok-Naaman, R and Barnea, N (2012). Laboratory activities in Isreal. *Eurasia Journal of Mathematics, Science and Technology Education*, 8 (1) 49 – 57
- Nwosu, A. A (2001) Gender and Acquisition of Science Process Skills among Secondary School Students: Implications for Science Teaching. STAN 42nd Annual Conference Proceedings 206-208.

- Tobin, K.G (1990). Research on science laboratory activities. In pursuit of better questions and answers to improve learning. *Social Science and mathematics*, 90(5) 403-418
- Ogunbunmi, S and Olaitan, U (1988) Elements of Physics in Yoruba culture. *Journal of African Physiology and studies*