



Levels of Scientific Literacy Among Basic Science Students in Junior Secondary Schools

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Abstract

The study determined the level of scientific literacy among basic science students in junior secondary schools in Nsukka L.G.A. A descriptive survey research design was adopted for the study. A total of 244 JSS 11 students (129 males & 115 females; 160 urban & 84 rural) were sampled for the study. Scientific Literacy Test (SLS) was used with a reliability coefficient of 0.60 using Kuder-Richardson (K-R-20). Data were analyzed using frequency and percentages and chi-square. The results of the study showed significant differences in the level of scientific literacy possessed among junior secondary school students in the area with majority (76.8%) of the students possessing nominal level of scientific literacy among others. It is recommended among others that there is need to develop a curriculum of basic science that will be geared towards the inculcation of the higher levels of scientific literacy.

Keywords: Scientific Literacy, Basic science, Junior secondary students, gender and

Introduction

In our contemporary society, science and technology is the fulcrum of societal rotation. This is because any member of the contemporary society that fails to embrace science and technology is shrouded in Dark Age. Evidently, science and technology has brought an unprecedented transformation in our present world. Thus, just with a click of mouse, information props up; at the comfort of one's home, millions of money is transferred; acquaintances, business partners and relatives are reached within nanoseconds. This then suggests the imperativeness of having sound knowledge of science and technology, especially how some of the technological gadgets brought about by scientific applications work and operate. Corollary, if students who are arts oriented must use cell phone, operate Automated Teller Machines (ATM), communicate in social media platform, transfer money via mobile Applications, use Wireless Fidelity (Wifi) among others, such students need to be scientifically literate.

The concept of scientific literacy has attracted diverse definitions with no common consensus. According to National Science Education Standards (2016), scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. Due to the diversity in definitions of scientific literacy, some scholars avoid the definition of the concept,

instead prefer to list the characteristics of scientific literate person. Thus, according to Twenty First Century Science (2008:4) a scientifically literate person is expected to be able to:

appreciate and understand the impact of science and technology on everyday life; take informed personal decisions about things that involve science, such as health, diet, use of energy resources; read and understand the essential points of media reports about matters that involve science; reflect critically on the information included in, and omitted from such reports; and take part confidentially in discussions with others about issues involving science

Similarly, according to National Research Council (1996:6), scientific literacy has five components, which are:

knowledge of significant scientific facts, concepts, principles and theories; ability to apply relevant knowledge in everyday life; ability to utilize the processes of scientific inquiry; an understanding of general ideas about the characteristics of science and important interactions of science, technology and society;



and the possession of informed attitudes and interests related to science.

For the authors, scientific literacy is the understanding of process, nature, and product of science including scientific ethics and values and use same in one's personal and societal decision making, problems solving, participate in science and technological discourse all for the refinement of one's immediate culture and politics. A scientific literate person should be able to make judicious use of technological gadgets, be an active participant in a local and national discourse on the use of science and technology for development. For example, if government wants to site a nuclear plant in a given area, a scientifically literate person should be able to make meaningful contributions on why the plant should be sited or not. This means that such a person should be armed with the knowledge of the advantages and disadvantages of nuclear energy, including the history of nuclear energy accidents and the likes. Suffice to say that such an individual must not be an expert in nuclear science, knowing all the intricacies of nuclear science and technology, but should have good knowledge of nuclear energy. Thus, what are the level of scientific literacy?

According to Shamos' (1995: p87-89), scientific literacy has three levels, namely cultural, functional and true scientific literacy. Cultural scientific literacy refers to a grasp of certain background information that communicators must assume their audiences already have. Functional scientific literacy refers to the requirement that the individual not only have command of a science lexicon, but also be able to converse, read, and write coherently, using such science terms in perhaps a non-technical but nevertheless meaningful context. While true scientific literacy refers to the individual having actually known something about the overall scientific enterprise, the major conceptual schemes of science, how they were arrived at, why they are widely accepted, how science achieves order out of a random universe, and the role of experiment in science. This individual also appreciates elements of scientific investigation, the importance of proper questioning, of analytical and deductive reasoning, of logical thought processes, and of reliance upon objective evidence.

Similarly, Bybee, Powell and Trowbridge (2008: 92) categorized scientific literacy into four levels namely, nominal scientific literacy, functional, conceptual/procedural, and multidimensional. A

nominal scientific literate person identifies terms, questions, as scientific but demonstrates incorrect topics, issues, information, knowledge, or understanding; has misconceptions of scientific concepts and processes; gives inadequate and inappropriate explanations of scientific phenomena; and expresses scientific principles in a naïve manner. A functional scientific literate person uses scientific vocabulary; defines scientific terms correctly; and memorizes technical words. Conceptual and procedural scientific Literate person, understands conceptual schemes of science; understands procedural knowledge and skills of science; understands relationships among the parts of a science discipline and the conceptual structure of the discipline; and understands organizing principles and processes of science. While a multidimensional scientific Literate individual understands the unique qualities of science; differentiates science from other disciplines; knows the history and nature of science disciplines; and understands science in a social context

Ironically, as important as scientific literacy is to the citizenry, previous studies (Ibe, 2013; Obi, 2019) have shown that students' possessed low knowledge of scientific literacy (nominal). However, majority of the studies if not all, where not situated at the basic education level, thus rubbing off the stakeholders the ideas of students' knowledge of scientific literacy at basic education level. Suffice to say that it is important to conduct studies on students' level of acquisition of scientific literacy at basic education level, so as to help catch them young and rekindle students' interest in science and technology early enough. It is against this backdrop that the present study is hinged.

Also of importance to this study is the contribution of gender on students' acquisition of scientific literacy. Previous studies, for example, Ebe (2013) showed that students' acquisition of scientific literacy is skewed to the males, Obi (2019) showed that students' acquisition of scientific literacy is not based on gender. In view of the differences in research findings, the present study is hinged. Thus, the purpose of the study is to determine the level of scientific literacy among Basic Science students in junior secondary school. Specifically, the study tends to:

1. find out the level of scientific literacy possessed by basic science students.



2. determine the influence of gender on students' level of scientific literacy possessed in Basic Science.
3. determine the influence of location on students' level of scientific literacy possessed in Basic Science.

Based on the purpose of the study, the following research questions were also posed to guide the study:

1. What are the levels of scientific literacy possessed by Basic Science Students?
2. What is the influence of gender on students' level of scientific literacy possessed in Basic Sciences?
3. What is the influence of school location on student's level of scientific literacy possessed in Basic Science?

Similarly, the following hypotheses were formulated to guide the study

1. The level of scientific literacy possessed by basic science students is not significant
2. The level of scientific literacy possessed by basic science students based on gender is not significant
3. The level of scientific literacy possessed by basic science students based on location is not significant

Research Method

Descriptive survey research design was adopted for this study. The design was chosen so as to make description systematically, factual and accurate about scientific literacy skills of junior high school students of Nsukka Local Government Area. The research was carried out in junior secondary schools in Nsukka Local Government Area of Enugu state, Nigeria. The Local Government has 22 rural and 8 urban secondary schools. The reason for using the schools in the area is because the local government is the place University of Nigeria, Nsukka is sited, with majority of the teachers teaching in most of the junior and senior secondary schools in the area being products of the university. This implies that the schools in the area should be pace setters in terms of teaching and learning and by extension the students in the area should possess sound scientific literacy. Another reason for chosen the area is due to existence of rural and urban areas and coeducational or mixed schools in the L.G.A. This is of importance since location and gender are two moderating variables of the study.

The population of the study was 8137 JSS II students drawn from 30 secondary schools in Nsukka Education zone. Out of these 8137 students, there were 4307 females and 3100 male students according to the Enugu State Secondary Education Board (2019). According to the statistics, there were 6,291 in the urban Secondary schools and 1,846 in the rural schools. The sample size for this study is 244 JSS II students (129 males and 115 females) (160 students from urban school and 84 students from rural schools). Simple random sampling technique by balloting was used to select 10 schools from the 30 schools in the area, thereafter, proportionate stratified sampling techniques was used to select students across two strata (urban and rural) from the already selected schools. This results to 3% selection of the sample from the population.

The instrument used for data collection was Scientific Literacy Test (SLT). The instrument was made up of two sections A and B. Section A dealt with personal information of the respondents. Section B has two parts, one dealt with science content, comprising of questions in Basic Science with multiple choices marked a, b, c or d; the other part dealt with the nature of science where the respondents answer "true or false" to the statements separated into the three scientific literacy level under study. The questions were structured in such a way that science students' levels of scientific literacy at the nominal, functional and structural were tested. The instrument was made up of a 30 item test instrument where 10 items addressed each level of the three levels of scientific literacy under study. The researchers carried out face validation of the instrument using experts in Science Education, Measurement and Evaluation from the Department of Science Education in University of Nigeria, Nsukka. The validation was based on language level clarity, whether the instrument addressed the content of science as well as nature of science in relation to nominal, functional and structural levels of scientific literacy. Based on the comments of the validators, some of the items of the instrument were reformed, corrected or deleted from the final draft of the instrument. The reliability estimate of the test instrument was determined for the instrument using the result of the trial "testing of the instrument". The trial testing of the instrument was carried out using a sample of 20 JSS II students offering basic sciences from a coeducational School in Nsukka L.G.A. Kuder Richardson Reliability Coefficient KR-20 was used to measure internal



consistency of the instrument and the test result for reliability was 0.65.

The researchers personally distributed the instrument in the selected schools and collected same for scoring. The administration of the instrument was carried out under strict examination condition to prevent malpractices and also during normal class hours and were collected on the spot. The research questions were answered using frequency and percentages while chi-square was used to test the null hypotheses at 0.05 level of significance.

Results

Below are the findings of the study in line with the research questions and hypotheses that guided the work

Research question 1: what are the levels of scientific literacy of students in basic science?

Table 1: Frequency and percentage ratings of levels of scientific literacy of students in basic science

S/N	Levels of Scientific Literacy	Correct Responses		Incorrect Responses		Total Freq.	Total %
		Frequency	Percentage (%)	Frequency	Percentage (%)		
1.	Nominal	187	76.8	57	23.2	244	100.0
2.	Functional	169	69.6	75	30.4	244	100.0
3.	Structural	168	68.9	76	31.1	244	100.0

From Table 1 it could be observed that majority 187(76.8%) of the students possessed nominal scientific literacy more than the rest.

Hypothesis 1: The level of scientific literacy possessed by basic science students is not significant

Table 2: Chi-square analysis of frequency ratings of levels of acquisition of scientific literacy of basic science students

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	46.489 ^a	2	.000
Likelihood Ratio	47.468	2	.000
Linear-by-Linear Association	31.592	1	.000
N of Valid Cases	7320		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 688.38.

Table 2 shows the Chi-square ($X^2=46.489$) and the probability value (asympt.sig=0.00) with degree of freedom of 2. It could be observed that probability value is less than 0.05 level of significance, thus the null hypothesis was rejected in favour of the alternative. This means that there is a significant difference in the basic science students' levels of scientific literacy possessed in favour of nominal literacy level.

Research question 2: what is the influence of gender on students' level of scientific literacy possessed in basic science?

Table 3: Frequency and percentage ratings of level of scientific literacy of students in basic science based on gender

S/N	Levels of Scientific Literacy	Gender	Correct Responses		Incorrect Responses		Total Freq.	Total %
			Freq.	Perc. (%)	Freq.	Perc. (%)		
1.	Nominal	Male	100	40.98	29	11.89	129	52.87
		Female	87	35.66	28	11.48	115	47.13
2.	Functional	Male	92	37.70	37	15.16	129	52.87
		Female	77	31.56	38	15.57	115	47.13
3.	Structural	Male	89	36.48	40	16.39	129	52.87
		Female	79	32.38	36	14.75	115	47.13

From Table 3 male students possessed more nominal (40.98%), functional (37.70%) and structural (36.48%) scientific literacy more than the females with nominal (35.66%), functional (31.56%), and structural

(32.38%). Although male students possessed more nominal scientific literacy than other scientific literacy levels. However, difference in gender will be clearly shown by the hypothesis.



Hypothesis 2: The level of scientific literacy possessed by basic science students based on gender is not significant

Table 4: Chi-square analysis of frequency ratings of levels of scientific literacy possessed by basic science students based on gender

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.012 ^a	1	.911
Continuity Correction ^b	.005	1	.946
Likelihood Ratio	.012	1	.911
Fisher's Exact Test			
Linear-by-Linear Association	.012	1	.911
N of Valid Cases	2440		

Table 4 shows the Chi-square ($X^2=0.012$) and the probability value (asyp.sig=0.911) with degree of freedom of 1. It could be observed that probability value is greater than 0.05 level of significance, thus the null hypothesis was upheld. This means that there is no significant difference in the male and female basics science students' levels of scientific literacy possessed.

Research question 3: what is the influence of school location on students' level of scientific literacy possessed in basic science?

Table 5: Frequency and percentage ratings of level of scientific literacy of students in basic science based on school location

S/N	Levels of Scientific Literacy	Location	Correct Responses Freq.	Correct Responses Per (%)	Incorrect Responses Freq.	Incorrect Responses Perc. (%)	Total Freq.	Total %
1	Nominal	Urban	128	52.46	32	13.11	160	65.57
		Rural	59	24.18	25	10.25	84	34.43
2	Functional	Urban	116	47.54	44	18.03	160	65.57
		Rural	53	21.72	31	12.70	84	34.43
3	Structural	Urban	115	47.13	40	16.39	155	63.52
		Rural	53	21.72	36	14.75	89	36.48

From Table 5 students in urban schools possessed more nominal (52.46%), functional (47.54%) and structural (47.13%) scientific literacy than the students in the rural schools that have lesser percentage in the nominal (24.18%), functional (21.72%), and structural (21.72%). Although urban students possessed more nominal scientific literacy than in others.

Hypothesis 3: The level of scientific literacy possessed by basic science students based on location is not significant

Table 6: Chi-square analysis of frequency ratings of levels of scientific literacy possessed in basic science students based on school location

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	74.342 ^a	1	.000
Continuity Correction ^b	73.871	1	.000
Likelihood Ratio	73.077	1	.000
Fisher's Exact Test			
Linear-by-Linear Association	74.332	1	.000
N of Valid Cases	7320		

Table 6 shows the Chi-square ($X^2=74.342$) and the probability value (asyp.sig=0.00) with degree of freedom of 1. It could be observed that probability value is less than 0.05 level of significance, thus the null hypothesis was rejected in favour of the alternative. This means that there is a significant difference in the basics science students' levels of scientific literacy possessed based on school location in favour of urban students.

Discussion of Major Findings

The result of this study showed that JSS 11 students in Nsukka local government areas possessed more levels of scientific literacy in basic science than other levels. This is in agreement with Saleh and Faki (2011) who stated that secondary school science students should possess scientific literacy at these levels. Be that as it may, the level of scientific literacy among the respondents in this study could be attributed to their level of education as their literacy level would increase with increase in scientific exploration which is associated with higher educational attainment. It could also be due to the teaching/instructional method adopted by the teachers



for the teaching of basic science in those schools. Majority of the students in this study were scientifically literate at the nominal level while more than half of the students had correct knowledge of basic science at the functional and structural levels of scientific literacy. That is to say that scientific literacy among JSS 11 students in Nsukka L.G.A was highest at the nominal level followed by the functional level and then the structural level. In support of this result, Nwagbo (2006) opined that secondary school students tend to possess lower levels of scientific literacy more than the higher ones.

This study showed also that gender has no significant influence on the level of scientific literacy possessed by the basic science students. However, male students had more scientific literacy at all levels compared to the female students. The insignificant relationship between gender and scientific literacy could be attributed to the fact that both genders have similar or equal interest and attitudes towards the study of basic science. However, the higher levels of scientific literacy reported among males than females could be due to higher number of males than females used in the study or due to the males having more confidence in the mastery of science skills compared to the female students. In contrast to other studies, Mukti *et al.* (2019) reported significant relationship between gender and scientific literacy among secondary school students with the female student possessing higher scientific literacy levels than the male counterparts. Also, Kristiyasari, Yaminah, Utomo, Ashadi and Indriyanti (2018) reported that students' literacy skills are influenced by gender differences with females having dominance in most literacy levels. However, a similar result was reported by Hardinata, Putri and Permanasari (2019) among secondary school students in Bandung, Indonesia where there was no significant difference between male and female students in three competencies of scientific literacy. In their study on the investigation of the effect of gender on students' scientific reasoning ability in Thailand, Piraksaa, Srisawasdi and Koulc (2014) also reported that gender does not significantly impact on students' scientific reasoning ability for each construct elucidated.

This study showed that school location has significant influence on the level of scientific literacy possessed by the basic science students in favour of urban students implying that most of the urban students possessed scientific literacy more than those in the rural areas. The significant association between

school location and student scientific literacy in basic science in favour of the urban students could be multi-factorial. It could be attributed to the fact that most rural schools lack adequate facilities for teaching and learning of basic science or due to differences in the methods of instruction adopted by the teachers in both locations. According to Kirunda (2005), rural schools have little or no access to such facilities such as laboratory equipment, library facilities, qualified teachers, electricity as well as electronic devices from which they could gain information, enrich their knowledge and develop literacy practices. Higher number of urban students than rural students used in this study as well as the lukewarm attitude of rural dwellers to western education could also be influencing factors. Be that as it may, the result of this study is comparable to other previous studies. For instance, Kryst, Kotok and Bodovski (2015) in his study on rural/urban disparities in science achievement in post-socialist countries, reported that students attending rural schools had significantly lower science scores than their urban counterparts. Umar and Samuel (2018) in their study on the investigation of school location as correlate of students' achievement in basic science also reported significant difference in Basic Science achievements between urban and rural students with students in urban schools having better achievement than those at rural settings. Likewise, Umar (2017) reported significant difference between rural and urban students' academic performances in biology in West African Examination Council with students in urban schools performing better than those in rural schools. In contrast to the result of the present study, Ajai and Imoko (2013) in their study on urban and rural differences in academic achievement and interest in geometry among students in Benue State, Nigeria reported that rural students achieved significantly better in mean achievement and interest scores than those in urban schools.

Conclusion

JSS 11 students in Nsukka local government area of Enugu state possessed nominal level scientific literacy in basic science. That is to say that the scientific literacy of JSS 11 basic science students in Nsukka L.G.A was highest for nominal level followed by functional level with structural scientific literacy being the least possessed by the students. Gender has no significant influence on the levels of scientific literacy possessed by basic science. Finally, school location



has significant influence on the level of science process skills possessed by the students.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. There is need to develop a curriculum of basic science that will be geared towards the inculcation of the higher levels of scientific literacy so that the students can possess enough scientific knowledge and skills to be scientifically literate.
2. Scientific literacy gap between rural and urban locations should be bridged by providing favourable school facilities and learning environment in the rural schools.
3. Recruitment of more qualified teachers for the teaching of basic science in secondary schools especially in the rural areas should be embarked on by the government.
4. There should be provision of laboratory equipment as well as electricity that will help teachers deliver science lessons to students in order to improve their level of scientific literacy.

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