

Students' Level of Scientific Literacy and Academic Performance in Physics Concepts in Rivers State, Nigeria

Aderonmu, Temitope S. B.¹ & Adolphus, Telima²

¹University Demonstration Secondary School, University of Port Harcourt, Rivers State, Nigeria

²Department of Science Education, Faculty of Education, Rivers State University Nkpolu-Oroworukwo, Port Harcourt, Nigeria

Abstract: The vision of every scientific community is the development of scientific literacy of its learners to proffer solutions to compelling scientific demands that is confronted in our everyday engagements. Acquisition of scientific literacy is a yardstick for societal development. Therefore, the study investigated students' level of scientific literacy and academic performance in Physics concepts. The study adopted the Ex-post facto research design method using 246 SS 3 Physics students selected for the study by random sampling technique in Obio-Akpor Local Government Area of River State, Nigeria. Instruments for data collection were "Questionnaire on Scientific Literacy Assessment Template" (QSLAT) with reliability coefficient index of 0.79 and raw scores of SS 3 students for first term 2019/2020 session in Physics. Data was analyzed using Multiple Correlation Analysis (MCA), Analysis of Variance (ANOVA) and Scheffe post-hoc analysis at 0.05 level of significance. The study revealed that relationship between level of scientific literacy and students' academic performance in Physics was statistically significant. Furthermore, the scientific literacy level of Physics students was low because most students were found to have their scientific literacy levels at the Nominal Scientific Literacy (NSL) followed by Functional Scientific Literacy, Structural Scientific Literacy while Multi-Dimensional Scientific Literacy was the least. The study recommended that Physics teachers should adopt instructional strategies that will be devoid of rote memorization but encourage active engagement of students in enhancing scientific literacy among others.

Key words: Physics, Science, Literacy, Scientific Literacy, Performance.

I. INTRODUCTION

The greatest power that man would ever yearn for is knowledge and understanding of the realities of basic components of nature, while providing sound explanation using cause-effect relationship. Basic knowledge or literacy is a function of intellectual growth. Literacy is simply the fulcrum to knowledge development and understanding required to function actively in a society. United Nations Educational Scientific and Cultural Organization (UNESCO) in 2017 stipulates that literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society. From the perspective of mathematics, literacy connotes the degree of mastery of basics mathematical symbols and recognition of numbers.

Literacy can be categorized into a spectrum consisting of basic literacy, cultural and civic literacy, functional literacy and scientific literacy.

Aderonmu, Aziaka and Arikawei (2016) explained that scientific literacy is a broad term that incorporates scientific ideas and concepts within and across various scientific discipline as well as scientific practice. Scientific literacy is the foundation of understanding scientific laws, principles and concepts which are essential for problem solving and decision making. Evidently, a scientific literate individual is one that have acquired scientific knowledge with the sole aim of proffering solutions to problems. Holbrook and Rannikmae (2009) opined that been scientific literate entails the knowledge and the applicability of science. Many natural phenomena encountered in our everyday life experiences can be explained by scientific principles and facts which abound in our environment. This can only be done by scientific literate individuals. A scientifically literate person has acquired the ability to hold a scientific worldview, engage in scientific inquiry, and appreciate the scientific enterprise. In order for the developed nations of the world to flow with the tide of scientific and technological transition, conscious effort have been made to structure their resources to the development and engagement of scientific literate citizens.

The complexities existing in all aspects of human endeavor have triggered scientific curiosity and consequently, necessitate the need for everyone to be scientifically literate. Importantly, the future of mankind in terms of sustainability and livelihood is largely dependent on the application of science and technology which is the tool required to confront societal challenges. Unfortunately, the potentials of science and technology cannot be achieved unless there is a deliberate effort in promoting the understanding of science and scientific literacy. Hodson (2008) reiterated that in order for the optimum attainment of scientific literacy of citizens, the schools have an important role to play. As such, the delivery of science content should be analytical, reflective, simplistic and interestingly packaged to empower students to be scientific literate. Science learning should be centralized on the development of scientific literacy and its usefulness in helping students solve every problems and making positive science related decisions.

Physics is one science subject that is aimed at developing the understating of basic scientific and natural phenomena that applies to everyday lives. The subjects present the link between the events in the in nature and their associated explanations. It is important to state that numerous natural occurrences that are seen, felt and perceived can be explained if a learner is scientifically literate. Aderonmu and Nte (2014) noted that learning of Physics instills in learners relevant knowledge and understanding including the ability to solve problems aimed at enhancing their scientific literacy. In recognition of the importance of scientific literacy, one objective of the Nigeria secondary school Physics curriculum stipulates that the study of Physics is to provide basic literacy for functional living in the society. Okoro (1999) as cited in Aderonmu, Aziaka and Arikawei (2016) provided levels of scientific literacy as regards the study of Physics. The following are the levels'

1. *Nominal Scientific Literacy (NLS)*: At this level, Physics learners can identify events and concepts that are scientific in nature, although they still possess misconceptions due to their baseline knowledge may not provide proper scientific explanations.
2. *Functional Scientific Literacy (FSL)*: Physics learners can identify describe and provide only limited scientific explanation of science concepts.
3. *Structural Scientific Literacy (SSL)*: Physics learners develop personal relevance and attitude in terms of curiosity, inquiry and interest in the study and applications of scientific and events.
4. *Multi-Dimensional Scientific Literacy (MLS)*: This level is characterized by Physics learners' understanding of the place of science and its interrelationship among other disciplines. Physics learners understanding the correlation between science, technology and society and as well apply scientific skills in solving societal problems.

A scientific literate person has the capacity to hold a scientific worldview, engage in scientific inquiry and appreciate the scientific enterprise. Afolabi and Mwakapenda (2014) lamented that despite the aim of designing the curriculum to inculcate and enhance scientific literacy of the learners in proffering solutions to real-life situations, scientific literacy in Nigeria is very low. With the immense benefits of scientific literacy for citizens and the nation at large, Oluwatelure (2012) observed that there are still irregularities and gaps between what is taught in the classroom and the level of applied scientific understanding of learners to their own task and problems inherent in the society. The issue of poor performance among secondary school Physics students both in internal and external examination as it fester alarmingly, is so dreadful that one wonders if such may be the reflection of unidentified factor such as students' level of scientific literacy. There is no doubt that scientific literacy of students is very crucial for the immediate environment and the society at large, it is on the basis the study was designed to investigate

the relationship between the students' levels of scientific literacy and performance in Physics concepts.

II. AIM AND OBJECTIVES OF THE STUDY

The study was aimed at correlating the relationship between students' level of scientific literacy and academic performance in Physics concepts in Rivers State, Nigeria. Specifically, objectives of the study are to:

1. Determine the relationship between students' levels of scientific literacy and performance in Physics concepts.
2. Ascertain the level of scientific literacy mostly acquired by Physics students.

Research questions

1. What is the relationship between students' levels of scientific literacy and performance in Physics concepts?
2. Which of the following levels of scientific literacy is mostly acquired by Physics students?

Hypothesis

One null hypothesis was tested for this study.

H₀: Students' level of scientific literacy does not significantly affect their academic performance.

III. METHODOLOGY

The study adopted the Ex-post facto research design method. Ex-post facto research is a systematic empirical inquiry in which the researcher does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulated. The research design compared the independent variable which is students' level of scientific literacy with the dependent variable, academic performance in Physics. The target population includes all Senior Secondary School 3 (SS 3) Physics students in Obio-Akpor Local Government Area of Rivers State, Nigeria. Using a random sampling technique, 246 Senior Secondary three (SS 3) students were selected in three schools.

Two instruments that were utilized for the study were Questionnaire on Scientific Literacy Assessment (QLSA) and raw scores of SS 3 students for first term 2019/2020 session in Physics. QSLTA was made up of 40 close ended questions that was structured on modified 4 point Likert scale of Strongly Agreed = (4 points), Agreed = (3 points), Disagreed = (2 points) and Strongly Disagreed = (1 point) that addressed the four levels of scientific literacy. Face and content validity was done by three measurement and evaluation experts in the University of Port Harcourt, Nigeria. QSLTA was further trail tested to 40 (SS 3) Physics students that was not used for the study. The data obtained was analyzed using the Cronbach's Alpha reliability coefficient statistics and a reliability index of 0.79. The data collected for the study was analyzed using the Multiple Correlation Analysis (MCA),

Analysis of Variance (ANOVA) and Scheffe post-hoc analysis at 0.05 level of significance.

IV. RESULTS

Research Question 1: What is the relationship that between students’ levels of scientific literacy and performance in Physics concepts?

Table 1: Analysis of Inter-correlation matrix showing the relationship between the independent variables and students’ academic performance in physics

Source	1	2	3	4	5
Performance	1.000				
Nominal Scientific Literacy	.721	1.000			
Functional Scientific Literacy	.472	.344	1.000		
Structural Scientific Literacy	.370	.024	.503	1.000	
Multi-Dimensional Scientific Literacy	.251	.018	.653	.060	1.000

Correlation is significant at the 0.05 level (2-tailed).

The analysis presented in Table 1 shows the Inter-correlation matrix showing the relationship between the independent variables and students’ academic performance in physics. The result revealed that students’ academic performance in Physics is significant and positively related to Nominal Scientific Literacy (NSL) [$r = .721$; $p < .05$], Functional Scientific Literacy (FSL) [$r = .472$; $p < .05$], Structural Scientific Literacy (SSL) [$r = .370$; $p < .05$] and Multi-Dimensional Scientific Literacy (MSL) [$r = .251$; $p < .05$]. The findings of the study revealed that the relationship between level of scientific literacy and students’ academic performance in Physics is statistically significant.

Hypothesis

H_{01} : Students’ level of scientific literacy does not significantly affect their academic performance.

Table 2: Analysis of Variance of Students’ Levels of Scientific Literacy and Academic Performance

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3895.600	3	1298.533	51.692	.000
Within Groups	14087.867	242	121.447		
Total	17983.467	245			

The above analysis presented in Table 2 is the ANOVA of students’ levels of scientific literacy and academic performance in Physics. It was observed that there is significant difference in students’ academic performance in Physics concepts consequent to the level of scientific literacy at $F_{(3,242)} = 51.692$; $p < .05$. Having observed the significant difference between the means of the level of scientific literacy, the Scheffe’s post hoc test was employed to

determine the margin of the significant difference between the obtained means.

Table 3: Scheffe’s post-hoc analysis of difference between the means of Levels of Scientific Literacy

Levels Scientific Literacy	N	Subset for alpha = 0.05	
		1	2
Multi-Dimensional Scientific Literacy	246	32.300	
Structural Scientific Literacy	246	34.700	
Functional Scientific Literacy	246	37.967	
Nominal Scientific Literacy	246		47.300
Sig.		.271	1.000

Means for groups in homogeneous subsets are displayed

Table 3 showed the Scheffe’s post-hoc analysis of difference between the means of Levels of Scientific Literacy. It was observed that the Nominal scientific literacy contributed most to the significant difference followed by functional scientific literacy, structural scientific literacy and finally, multi-dimensional scientific literacy.

Research Question 2: Which of the following levels of scientific literacy is mostly acquired by Physics students?

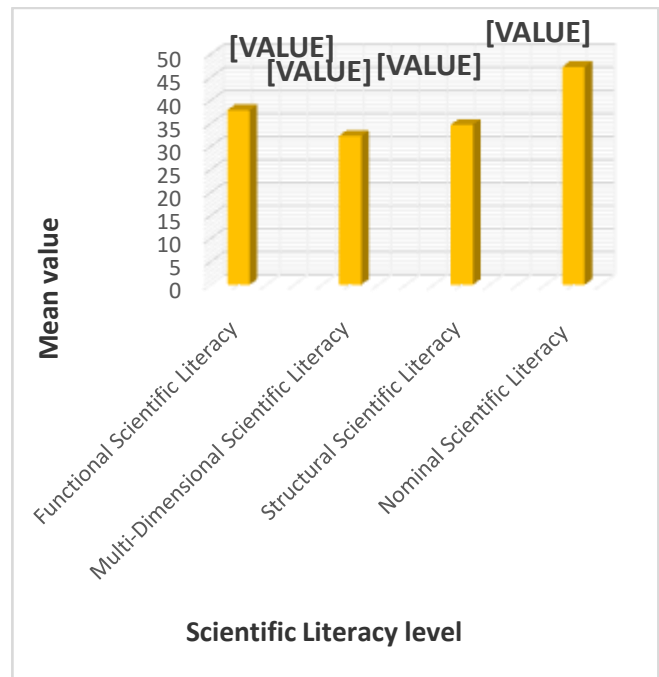


Fig 1: analysis of mean values for Levels of Scientific Literacy

Analysis shown on Fig 1 is the mean values between the level of scientific literacy and students’ academic performance in Physics. It was indicated that the Nominal Scientific Literacy (NSL) had the highest mean value of 47.3 followed by Functional Scientific Literacy with a mean value of 37.9. Structural Scientific Literacy and Multi-Dimensional Scientific Literacy had mean values of 34.7 and 32.3 respectively. The findings of the study therefore revealed that

scientific literacy level of Physics students was highest at the Nominal Scientific Literacy (NSL) followed by Functional Scientific Literacy, Structural Scientific Literacy while Multi-Dimensional Scientific Literacy was the least.

V. DISCUSSION OF FINDINGS

The study was concerned on correlating the relationship between the level of scientific literacy and student's academic performance in Physics. It was found that the relationship between level of scientific literacy and students' academic performance in Physics is statistically significant. This finding signifies that students who are scientific literate will perform better in Physics than those that are not scientifically literate. The finding collaborates with the outcome of Obama (2019) where it was found that there is positive relationship scientific literacy and academic performance of Chemistry students. The first objective of secondary school Physics curriculum in Nigeria is to prepare scientifically literate students who can use the underlying principles to improve their own lives, cope with an increasingly complex technological world, and make science-related decisions as responsible citizens. Students require unified understanding of "real science" with strong hold of scientific literacy that will promote constructive thinking.

Further evidence from the study showed that Physics students' scientific literacy is mostly prevalent at the nominal literacy level. Nwanekezi and Arokoyu (2016) expressed that there are ample evidence that shows that scientific literacy is undesirably low and limits the drive towards technological achievements in a dynamic technological driven society. The low level of scientific literacy as revealed in the current study collaborates with findings of Siagian, Silitonga and Djulia (2017) where it was founded that the scientific literacy skills of seventh-grade junior high school students' level of scientific literacy is very low. Oluwatelure (2012) and Aina, Abdulrahman and Ayodele (2020) in different studies also substantiate the findings of this study where it was also revealed that students did not possess the scientific literacy skills required for them to function effectively after graduation in society. Laugksch (2000) reasons that higher levels of scientific literacy would tend to increase support for science and provide the public with a more realistic expectation of science and its capabilities.

VI. CONCLUSION

The Current explosion of information and technology which has restructured all economic system to a knowledge-based economy requires a knowledgeable and scientific literate citizens. Scientific literacy entails higher-order innovative thinking, curiosity, understanding and explanation of nature phenomenon using cause-effect relationship. Students with scientific literacy knowledge and understanding of science concepts, ask probing questions during inquiry process,

sensitive to determine answers from daily experience. They can identify scientific issues and possess the ability to engage in scientific discuss at local or national levels.

VII. RECOMMENDATION

Based on the findings of the study, the following recommendations were posited;

1. Physics teachers should adopt instructional strategies that will be devoid of rote memorization but encourage active engagement of students in enhancing scientific literacy.
2. The Physics curriculum should be re-visited and contents that promote acquisition of scientific should be integrated.
3. Government should encourage special programmes like workshops, local, state or regional competitions aimed at the promotion of scientific literacy of students

REFERENCES

- [1] Aderonmu, T. S. B. & Nte F. U. (2014). Diagnosing Error Pattern of Physics Students in Solving Problems Using Progressive Wave Equation (PWE) in Senior Secondary Schools in Rivers State. *ARPJ Journal of Science and Technology*, 4 (4), 277-281.
- [2] Aderonmu, T. S. B., Aziaka, L. S. & Arikawei, R. A. (2016). Ripple effect of African cosmological belief in promoting scientific literacy for African development. *Niger Delta Journal of Education*. 8(1), 70-88.
- [3] Afolabi, F., & Mwakapenda, W. (2014). Science literacy in Nigeria: Veritable tool for development by the year 2020. *Cypriot Journal of Educational Sciences*. 9(3), 175-183.
- [4] Aina, J. K., Abdulrahman A. O. & Ayodele M. O. (2020). Assessment of Scientific Literacy Skills of College of Education Students in Nigeria. *American Journal of Social Sciences and Humanities*, 5(1): 207-220.
- [5] Hodson, D. (2008) *Towards Scientific Literacy. A teacher's guide to the History, Philosophy and Sociology of Science*. Rotterdam: Sense Publishers.
- [6] Holbrook, J., & Rannikmae, M. (2009). The meaning of scientific literacy. *International Journal of Environmental and Science Education*, 4(3), 275-288.
- [7] Laugksch, R. C.(2000). Scientific literacy: A conceptual overview. *Science Education*. 84:71-94.
- [8] Nwanekezi, A. U. & Arokoyu, A. A. (2016). *Science Education: Theory and Research*. Bengoddy Prints. Port Harcourt.
- [9] Obama, J. (2019). Influence of Scientific Literacy on Academic Performance of Chemistry Students in Yakurr Local Government Area of Cross River State, Nigeria. Retrieved from <https://ssrn.com/abstract=3511493> 12th January, 2020.
- [10] Oluwatelure, T. A. (2012). Investigation into the Scientific Literacy Level of the Nigerian University Undergraduates. *British Journal of Education, Society & Behavioural Science*. 2(2), 139-149.
- [11] Siagian, P., Silitonga, M., & Djulia, E. (2017). Scientific literacy skills of seventh grade junior high school (SMP Negeri) students in North Labuhanbatu Regency. *International Journal of Humanities Social Sciences and Education*, 4(11), 176-182.
- [12] UNESCO (2014). Defining Literacy. Retrieved from http://gaml.uis.unesco.org/wp-content/uploads/sites/2/2018/12/4.6.1_07_4.6-defining-literacy.pdf on 13th January, 2020.