



Assessing Levels of Scientific Literacy Among Final Year Physics Students in Colleges of Education in the South-East Zone of Nigeria

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Abstract

Levels of scientific literacy among final year physics students in colleges of Education in the South-East zone of Nigeria was investigated. Descriptive survey research design was used in the study with a population of 578 final year physics students in colleges of education in the South-East zone of Nigeria. A multistage sampling procedure was used to draw a sample of 273 from the population. Physics Literacy Test (PLT) was developed with face and content validation and reliability coefficient of 0.79 was determined using Kuder-Richardson Formula 20 (KR-20). Frequency and percentage were used to answer research questions and Chi-Square was used to test the hypotheses at 0.05 level of significance. Findings: most NCE Physics students attained the functional level of scientific literacy and no significant difference in the physics literacy levels of male and female Physics students. Proper monitoring of the colleges reflective of NCE minimum standard was recommended.

Keywords: Scientific Literacy, Physics science, College of Education students, gender

Introduction

Science is very important in every human environment as it is regarded as the indispensable vehicle for transmission of societal culture, values, ideals and norms through education. These societal virtues form the basis of educational policy formulation for growth and development on the society. In recognition of this fact, the National Policy on Education (2014) clearly stated that education is a tool for national development and social change. In this policy formulation, educational procedure emphasizes science which is the systematic study of nature and natural phenomena (Adeleke, 2015). For proper understanding of science, scientific concepts, skills, facts and theories must be well articulated and understood. The adequate acquisition of scientific knowledge, skill and attitude is very vital for meaningful human existence and development; based on this, Sani and Ikpe (2019) opined that science, physics inclusive, has utility value through the use of scientific Literacy for coping with life challenges (Badmus & Bada, 2020).

Physics is one of the science disciplines. Physics is the study of matter in relation to energy (Day

et al, 2016). It is one of the core science subjects studied in senior secondary school with defined curriculum designed for achievement of objectives in secondary schools. One of the objectives of studying physics as defined in the current senior secondary school physics curriculum (2008) is acquisition of basic concepts and principles of physics as a preparation for further studies- college of education inclusive (Nigerian Educational Research and Development Council, 2008, p 5).

College of Education is a tertiary education in Nigeria charged with the function of training teachers to get non-degree but qualitative professional certificate in education. It is very clear that the student achievement in senior secondary physics influences his/her progress in tertiary education physics in the colleges of education in addition to certain factors like gender (Kristyasari et al 2018, Aina, Abdulgafar and Tobias et al 2019, Nwagbor, 2012 & Shahzadi and Nasreen, 2020).

This is why it is very good to know the level of possession of scientific literacy on the final year physics



students of the colleges of education to know if they still possess the needed requisite knowledge which they suppose to use in helping the society at secondary school level. This is called for following poor performance in area of physics. The evidence of poor performance in physics has been recorded in senior school certificate examination as from 2019 to 2022 students' trend of performance in May/June West African Senior School Certificate Examination which may poor possession of poor scientific literacy (Chief Examiners Report, 2019, 2020, 2021 & 2022).

In line with Bybee (1997) which this study adopted, there are four levels of scientific literacy which are nominal, functional, structural/conceptual and multidimensional scientific literacy. Nominal scientific literacy. this is a level that goes with certain misconception about science. Students at this level recognizes a concept as linked to science, but its clear comprehension can indicate misconceptions (Bybee, 1997). At Functional Scientific Literacy level the students at this level can give the description of a concept correctly, but have limited understanding of the concept (Bybee, 1997).

Also, in Conceptual/structural scientific literacy, at this level the students not only understand the procedural knowledge, conceptual schemes and skills of physics but can also show the explanations in their own expressions. Multidimensional Scientific Literacy in the other hand involves an understanding of science that goes beyond the concepts of scientific fields and procedures of scientific inquiry. It contains philosophical, historical, and social dimensions of science and technology. However, gender may not be unconnected to low science literacy among the students of the colleges of education. Researchers have shown that gender affects the achievement of students in science, physics inclusive. Gender is a social, historical and cultural construct and conditioning, showing acceptable and preferable kinds of behaviour and attitude in the society for both male and female (Kristiyasari, Yamtinah, Utomo, Ashadi, & Indriyanti, 2018).

The general purpose of this study is assessing the level of scientific literacy among final year physics students in colleges of Education in the South-East zone of Nigeria. Specifically, the study found out the:

1. physics literacy levels of final year Nigeria Certificate in Education (NCE) physics students.
2. influence of gender on the physics literacy levels among final year Nigerian Certificate in

Education (NCE) physics students. Consequent upon the purpose of the study,

The following research questions were posed for the study:

1. What is the physics literacy levels of final year Nigeria Certificate in Education (NCE) physics students?
2. What is the influence of gender on the physics literacy levels among final year Nigerian Certificate in Education (NCE) physics students?

Therefore, this hypothesis was formulated for the study, and it was tested at 0.05 level of significance.

There is no significant difference in the of physics literacy levels of the male and female physics students in South- East zone of Nigeria.

Research Method

For the study, a descriptive survey research design was used. The study's focus is the South-East region of Nigeria, which includes the states of Abia, Anambra, Ebonyi, Enugu, and Imo. The zone has fourteen accredited colleges of education that offer physics education course.

The population of this study consists of all the 578 final year Physics students in all the colleges of education in the South-East zone of Nigeria. The zone has fourteen accredited colleges of education that offer physics course. The population is made up of 110 male and 468 female physics students (NCCE, 2023). Final year Physics students was used because the students would have covered the selected contents used in the study in addition to the fact that they have gone far in the tertiary institution to the extent that they are on the verge of graduation to teach physics in secondary school, therefore there is need to find out if they possess the required knowledge of the secondary school physics curriculum they will use to impact physics literacy on the secondary school physics students so that we do not live in assumption of what may not be through consequently, the need to know their physics literacy statues is justifiable at this point.

The sample of the study comprises of 273 final year Physics students, comprising of 53 males, and 220 females; sampled from 8 Colleges of Education out of 14 accredited colleges of education that offer physics education using multistage sampling procedure. First, simple random sampling technique was used to select two of the five States in South-East Nigeria which are



Enugu and Anambra. Then, purposive sampling technique was used to sample four Colleges of Education each from Enugu and Anambra States that offered NCE Physics Education programme.

The instrument for data collection is a Physics Literacy Test (PLT), which was developed by the researcher. The PLT was developed based on the ideas taught in the SS Physics curriculum, which included the interaction of matter, space, and time, the conservation principle, waves, motion without transfer, fields at rest and in motion, energy quantization, and the duality of matter. It was a 40-item multiple-choice objective test based on physics literacy. In order to properly cover the contents chosen as well as the degrees of physics literacy, the items were constructed using the table of specifications. The developed PLT instrument was subjected to face validity. Three experts from the Department of Science Education (one Measurement and Evaluation and two from the Physics Education) validated the instrument and trial testing of the instrument was done outside the study area. A reliability index of 0.79 was obtained for the instrument using Kuder-Richardson Formula 20 (KR-20). The researcher recruited one physics lecturer from each of the sampled Colleges of Education and briefed them about the research and the instrument for data collection. These lecturers that served as research assistant, were given the instrument to distribute to respondents within the school environment and classrooms. The direct delivery and retrieval method was used to collect data to ensure 100% return of the instruments.

Data collected were analysed using the Statistical Package for Social Sciences (SPSS) version 25. Findings were presented in tables and charts. Research questions were answered using frequency and percentages, while the hypotheses were tested at 0.05 level of significance using chi-square analysis. In the classification of the scientific literacy levels, these ranges were used:

- 0-25 Nominal level
- 26-50 Functional level
- 51-75 Structural level
- 76-100 Multidimensional Level

The scores were first converted to 100 before classification.

Results

The results of this study were presented in this section. The analysis of data for this study with respect to each research question and hypothesis raised were presented using tables and bar chart.

Table 1: Frequency and percentage for Physics literacy levels of final year Nigeria Certificate in Education (NCE) Physics students.

S/N	Physics Literacy Levels	Frequency	Percentage (%)
1	Nominal	17	6.2
2	Functional	147	53.8
3	Structural	108	39.6
4	Multidimensional	1	0.4
Total		273	100.0

Table 1 presents results from the analysis of data collected to determine the Physics literacy levels of final year Nigeria Certificate in Education (NCE) Physics students. The result shows that 17 students (6.2% of the sample) attained the nominal level of physics literacy, whereas 147 students (53.8% of the sample) attained the functional level. Also, 108 students (39.6%) attained the structural level while only 1 student (0.4% of the sample) attained the multidimensional level of Physics literacy. Overall, the result shows that majority of final year Nigeria Certificate in Education (NCE) Physics students attained the functional level of Physics literacy. This result is further depicted by the bar chart below.

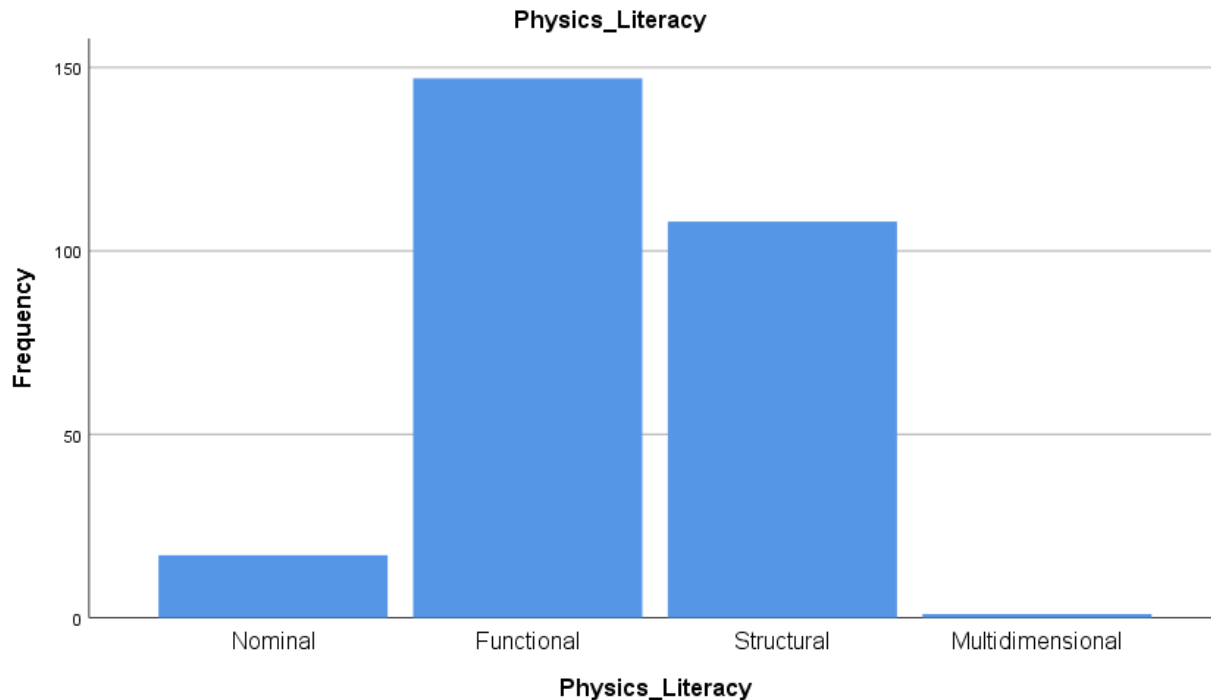


Figure 1: Bar chart showing the frequency of physics literacy levels among NCE Physics students. This chart shows that multidimensional physics literacy level has the least number of NCE physics students with frequency of 1, followed by nominal level, structural level and functional levels with frequency of 17, 108 and 147 NCE physics students respectively. That means that most students are at the functional level of physics literacy.

Table 2: Frequency and percentage for influence of gender on Physics literacy levels of final year Nigeria Certificate in Education (NCE) Physics students.

S/N	Physics Literacy Levels	Gender	Frequency	Percentage (%)
1.	Nominal	Male	3	1.1
		Female	14	5.1
2.	Functional	Male	26	9.5
		Female	121	44.3
3.	Structural	Male	24	8.8
		Female	84	30.8
4.	Multidimensional	Male	0	0.0
		Female	1	0.4
Total		Male	53	19.4
		Female	220	80.6

Table 2 presents result of the analysis of data collected to determine the influence of gender on Physics literacy levels of final year Nigeria Certificate in Education (NCE) Physics students. The result shows that some students attained the nominal level of physics literacy; 3 (1.1%) of which are males and 14 (5.1%) are females, while some students attained the functional

level, of which 26 (9.5%) are males and 121 (44.3%) are females. Also, some NCE Physics students attained the structural level of Physics literacy, of which 24 (30.8%) are males and 84 (8.8%) are females. At the multidimensional level of Physics literacy there was only 1 female student (0.4%) and no male student. This result is further depicted by the bar chart below.

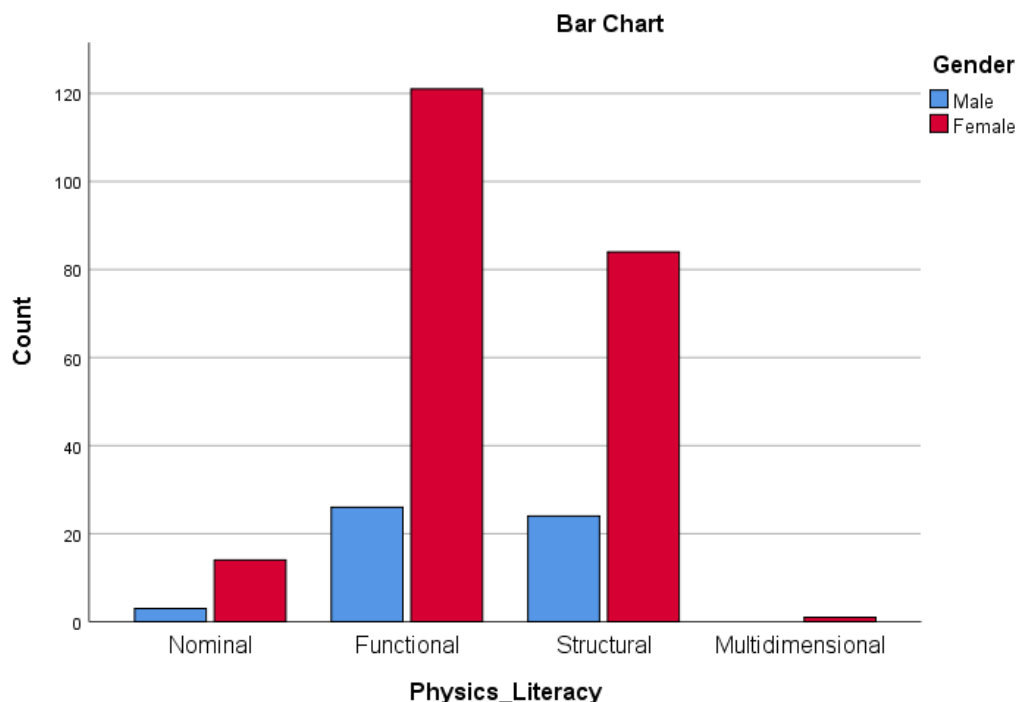


Figure 2: Bar chart showing the frequency of physics literacy levels of male and female NCE Physics students. This chart shows that at nominal physics literacy level, male gender has frequency of 3 while gender has frequency of 14. But at functional level male students have frequency of 26 while their female counterpart had frequency of 121. At structural physics literacy level total frequency of 24 is for the males while frequency of 84 is for the females, but at multidimensional physics literacy level there exist no male while there exist 1 female.

In the hypothesis, there is no significant difference on the physics literacy levels of male and female Physics students in South-East zone of Nigeria, the result showed:

Table 5: Chi-Square Test (χ^2) analysis on the difference on the physics literacy levels of male and female Physics students in South-East zone of Nigeria.

Gender	N	χ^2	df	Sig.	Dec.
Male	53	1.099	3	0.746	NS
Female	220				

NS = Not significant

Table 5 above shows the Chi-Square test result on the significance difference on the difference on the physics literacy levels of male and female Physics students in South-East zone of Nigeria. The result shows that, χ^2 (df = 3) 0.746, $p > 0.05$ were obtained. Since the associated exact probability value of 0.746 is greater than 0.05 level of significance, the null hypothesis was not rejected. This means that there is no significant difference on the physics literacy levels of male and female Physics students in South-East zone of Nigeria. Inference drawn is that the literacy levels of male and female NCE students in South-East zone of Nigeria does not vary.

Discussion

The study revealed that majority of the NCE Physics students (53.8%) are at the functional level of Physics literacy. At this level (functional level of physics literacy), students possess the ability to define scientific terms, as well as understand and utilize scientific concepts, albeit in a limited way. Students at this level can recognize scientific phenomena and apply basic scientific knowledge in specific situations, but their understanding is often shallow and lacks the ability to critically analyze information or apply scientific knowledge broadly. This is an indication that majority of Physics NCE students have moved past the nominal level of Physics literacy where they can only



recognize Physics concepts, but still demonstrate some misconceptions. Teacher trainees at the NCE level are prepared to teach Physics at the secondary school level. As a result, their curriculum content is designed in a manner that will equip them with knowledge of Physics concepts and a clear understanding of these concepts. As a result, these students will possess the clarity of concepts that students at the nominal level will not possess. However, the traditional education approach which encourages students to memorize concepts and pass examinations limits these students' ability to operate at the structural level of scientific literacy. This does not give students that chance to develop critical thinking skills or solve practical problems related to Physics issues. Also, the limited exposure of NCE students to scientific inquiry, shortage of hands-on activities and insufficient focus of lesson contents on real-world application of Physics concepts, contributes to limiting NCE students to the functional level of scientific literacy. This explains why only 39.6% of NCE Physics students were found in this study to be at the structural level of scientific literacy by demonstrating a deeper grasp of Physics concepts.

This finding supports that of Shahzadi and Nasreen (2020), who reported that majority of science students attained the nominal and functional level of scientific literacy. This was corroborated by Mat-Noor (2021) who reported that more science students attained the functional scientific literacy level than any other level. The finding however contradicts that of Aderonmu and Adolphus (2021), who reported that majority of Physics students were found to be at the nominal level of Physics literacy. This disparity in finding could be attributed to the fact that the authors carried out their study using only senior secondary school students whose Physics curriculum is slightly less advanced than those of NCE Physics students in Colleges of Education.

Result from the study show that more female NCE students (220) attained all four levels of Physics literacy than their male counterparts (53). There also was a significant difference on the physics literacy levels of male and female NCE Physics students. In most Physics classrooms, especially at the NCE level, there are more female students than there are males. Physics is stereotypically considered a "male field" and so it is expected that there will be a male dominance in Physics programmes. This is however not the case in Colleges of Education because several other subject areas like Biology, Chemistry, and Mathematics are combined with Physics. These fields are typically

female-dominated and when females combined the subject areas with Physics, Physics education becomes a female dominated field at Colleges of Education. As a result of this dominance, it is often likely to find more female NCE Physics students attaining all levels of Physics literacy than male students. Also, NCE programmes typically prepare students for teaching careers at the secondary school level. The teaching profession in Nigeria is perceived as being a female-dominated field and so more females are likely to take up and be interested in NCE programmes than males, ultimately resulting in more females in the NCE Physics education programme. The stereotype around the profession would mean lecturers in Colleges of Education would have different expectation of female Physics NCE students than they would have for male students. This can somewhat nudge them towards challenging female students a little more than they would male students, resulting in the former attaining higher levels of Physics literacy than the latter. However, the fact that all four literacy levels were found to be dominated by females can be purely attributed to the higher number of female students in NCE Physics classrooms than male students. The study also showed that there was no significant difference in Physics literacy levels of male and female NCE students, indicating that overall, the Physics literacy of NCE Physics students is not influenced by gender. Male and female Physics students are taught with the same curriculum, by the same teachers and under the same learning conditions. So, considering that the development of scientific literacy is largely determined by classroom Physics activities, male and female NCE Physics students would have similar literacy levels and would not differ considerably.

This finding is in agreement with that of Aina, Abdulgafar and Ayodele (2020) who reported that male students possessed more scientific literacy skills than their female counterparts. The finding also supports that Tobias et al (2019) found out that there was no significant gender gap in scientific literacy levels among male and female students in introductory Physics class. This finding however contradicts that of Kristiyasari et al. (2018) who reported a significant difference in scientific literacy levels among male and female students, with female students reportedly attaining higher levels of scientific literacy than male students. This variation in finding could be attributed to the fact that the study included students from all science fields, potentially accounting for more females than males.



Conclusion

This study revealed that a substantial portion of NCE Physics students fall within the functional and structural levels of physics literacy. This result highlights the need for improvements in NCE physics education to equip future teachers with deeper physics knowledge and the ability to effectively guide their students towards a more robust understanding of the subject. This finding showed that there was no significant difference in Physics literacy levels across genders. This suggests that demographic variables may not be the primary determinants of physics literacy in the context of NCE programs in Nigeria, as other factors like teacher-related variables and student-related variables can play a role in this regard. These results highlight the need for the National Commission for Colleges of Education (NCCE) in Nigeria to re-evaluate the current physics curriculum and teaching methods, emphasizing a deeper understanding and application of physics concepts through hands-on activities, scientific inquiry, and real-world applications. This shift in focus can empower future physics teachers to cultivate a more scientifically literate citizenry.

Recommendations

The following recommendations are made for the study:

1. The NCCE Physics curriculum should be reviewed by the national Commission for Colleges of Education (NCCE) to include contents that challenge NCE Physics students to think critically on the contents they are taught. This can help NCE Physics students attain higher levels of Physics literacy up to multidimensional level with all of them at multidimensional level.
2. Most private-owned Colleges of Education in the study area do not offer Physics Education programme. As a result, the researcher was restricted to the few colleges which offered the programme and so not many students were sampled from private schools.

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