

**INFLUENCE OF SCIENCE AND TECHNOLOGY EDUCATION ON  
STUDENTS' LEVEL OF SCIENTIFIC AND TECHNOLOGICAL  
LITERACY (STL) FOR SUSTAINABLE DEVELOPMENT IN NIGERIA**

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**Abstract**

*This study aimed to assess the impact of science and technology education on the degree of scientific and technical literacy (STL) among students in Nigeria, with a focus on its implications for sustainable development. The study employed a descriptive survey research approach. Three research questions and three hypotheses generated at a significance level of 0.05 served as the study's guiding principles. A total of 430 students were included in the sample, including 242 male students and 188 female students. A multistage sampling procedure was employed to choose the participants. The Scientific Literacy Test (SLT), which was approved by three experts, was administered with a reliability coefficient of 0.76, as determined by the Kuder Richardson (KR-20) method. The data gathered were analysed using statistical techniques such as frequency analysis, percentage calculations, and analysis of variance (ANOVA). The study's findings revealed notable disparities in the scientific and technical literacy levels of science students. A majority of the students (73.5%) had a nominal level of scientific and technological literacy compared to their peers. One recommendation is to address the scientific and technical disparity among science students by employing suitable educational resources that may augment their understanding and proficiency in the field of science.*

**Keywords:** Science, technology, education, scientific literacy, technological literacy: sustainable development

### **Introduction**

Efforts to achieve education for all must be linked to a drive to raise levels of scientific and technological literacy. A level of scientific and Technological Literacy ( STL) is of great importance, as it leads to the understanding of the fundamental concepts and methods of science together with the development of problems solving skills and the ability to make decision based on sound judgment and values in the society. This will ensure sustainable development. Science and technology have brought about lot of changes in the world today and will surely continue to do in the future (Yero &Saleh, 2014), thus there is the urgent need for a world community of scientifically and technologically literate citizens. This is essential in order to live functional life in the natural environment of the world and to enhance the overall quality life of its Populace in this 21st century that can guarantee sustainable development. To produce a scientifically and technological literate citizen, science and technology education must be accord its proper place and priority in the education system.

Science and technology education is a discipline that involves the transmission of scientific and technological concepts, methods of teaching and addressing scientific misconceptions held by learners. Science and technology education is very vital to sustainable development. Any developing nation that aspires to meet up with the developmental strides of the developed nations must ensure that science and technology education is given priority in all her institutions of learning, ranging from primary, secondary and higher institutions of learning. Many of the developed nations of the world ware able to achieve so much in areas of development and security based on science and technology education (Abuh, 2022). More so, science and technology education is a tool for social transformation growth and sustainable development. It breeds the best brains, builds the best workforce, develop the best social beings and assures formidable teams of learners and followers in the nation (Aina,2 018). In fact, Human ability to survive in his environment depends on his constant involvement in the acquisition and impartation of scientific and technological knowledge through the direct or indirect teaching and learning of science and technology education.

Furthermore, science and technology education involves the inculcation of scientific and technological literacy that enable the citizens to live a functional life, use resources and improve on the quality of living. It is also an educational system that prepares citizens of any nation for a successful integration in the society. It sharpens their quest for further knowledge and enable them to meet their basic necessities of life such as shelter, health, food etc. it promotes industrialization, free them from fears and superstitions while promoting law and orders in the society, which culminates to promoting sustainable development (Ujah, 2019). From the

foregoing, the researchers infer that science and technology education is the application of scientific and technological knowledge to tackle daily challenges being faced by individuals. It is instrumental to the transformation and positive changes that occur in the various parameters of a nation's life. Its impact is felt in the areas of health, shelter, food, security, unemployment, recreation, law and order, acceptance and tolerance, morality rates, rights and privileges etc. It can therefore be deduced that science and technology education could be an efficient instrument for promoting students level of scientific and technological literacy for sustainable development in Nigeria. In this study, scientific and technological literacy is the understanding of process, nature and product of science and technology, including scientific ethics and values and use same in one's personal and societal decision making, problem solving, participate in science and technological discourse, all for the refinement of one's immediate culture for sustainable development and politics. A scientific and technologically 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 and technologically 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 merits and demerits of nuclear energy, including the history of nuclear energy accident and likes. Suffice to say that such an individual must not be expert in nuclear science, knowing all the intricacies of nuclear science and technology, but should have good knowledge of nuclear energy. Scientific and technological literacy implies that a person can identify scientific and technological issues underlining national and local decisions and express position that are scientifically and technological informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of the source and method used to generate it. Scientific and technological literacy also implies capacity to pose and evaluate arguments based on the evidence and to draw conclusion, from such argument appropriately (Shamos, 2014). Thus, what are the level of scientific literacy expected of learners?

According to Bybee, powell and Trow bridge (2008) in Orji (2021), Scientific and technological literacy have four levels namely cultural or nominal, functional, conceptual or true scientific or structural and multi-dimensional scientific literacy. Cultural or nominal scientific and technological literacy pertains to the understanding of specific foundational knowledge that communicators must presume their listeners possess. Functional scientific literacy encompasses the necessity for individuals to possess not just a comprehensive understanding of scientific terminology but also the ability to effectively communicate, comprehend, and articulate scientific concepts in a logical manner, even in non-technical

contexts that nonetheless hold significance. The term "conceptual," "true scientific," or "structural" pertains to an individual possessing knowledge about the fundamental aspects of the scientific endeavour. This includes understanding the overarching conceptual frameworks of science, their origins, widespread acceptance, the manner in which science brings order to a chaotic universe, and the significance of experimentation in scientific inquiry. The person in question also demonstrates an appreciation for the components of scientific inquiry, such as the significance of formulating appropriate inquiries, employing analytical and deductive reasoning, engaging in logical thinking processes, and relying on objective data. A scientifically educated individual with a multidimensional perspective possesses an understanding of the distinctive characteristics, historical development, and fundamental principles of several scientific fields while also recognising the broader societal implications of science. Scientific and technological literacy is of great importance to the citizenry because it enables them to live a functional, efficient, profitable life and to contribute positively to societal development.

Despite the importance of scientific and technological literacy to the citizenry, previous studies (Nwagbo, 2002,Boja, 2007, Olufolajini 2009, Ali 2012; Ibe, 2013; Obi, 2019, Orji, 2021) have shown that students possessed low knowledge of scientific and technological literacy (Nominal). Nominal level of scientific and technological literacy is not good enough, students need to step-up their Scientific and technological level through the use of science and technology education in order to rekindle the interest of both male and female students. It is against this backdrop that the present study is hinged.

Another variable of interest to this study is the contribution of gender on students acquisitions of scientific and technological literacy. Previous studies, for example Ibe(2013) showed that students acquisition of scientific literacy is skewed to the males, Uja (2019) showed that student acquisition of scientific literacy is not based on gender. Chris (2018) reported that students literacy skills are influenced by gender differences with female having dominance in most-Literacy levels. However a similar result was reported by peter (2019) among secondary school students in Indonesia where there was significant differences between male and female students in three competencies of scientific and technological literacy. In view of the differences in research findings, the present study is hinged. Thus, the purpose of the study is to determine the influence of science and technology education on students' level of scientific and technological literacy for sustainable development in Nigeria.

### **Research Questions**

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 and technological literacy possessed by students
2. What is the influence of science and technology subjects on students' level of scientific and technological literacy acquisition
3. What Is the influence of gender on students level of scientific and technological literacy possession in Science and Technology

#### **Hypotheses**

The following hypotheses formulated at 0.05 level of significance were tested in this study:

1. The level of scientific and technological literacy possessed by students is not significant
2. The level of scientific and technological literacy possessed by students base on Scientific and technology education is not significant
3. The level of scientific and technological literacy possessed by students based on gender is not significant

#### **Methodology**

The study employed a descriptive survey research design. The selection of the design was made with the intention of systematically and accurately describing the scientific literacy skills of senior secondary school pupils in the Kogi East Education Zone. The study was conducted inside the Kogi East education zone of Kogi State. The region comprises nine local government areas, namely Ankpa, Omala, Olamaboro, Dekina, Ofu, Idah, Ibaji, Igalamela, Odulu, and Bassa. Kogi East is geographically next to Benue State in the western direction, while its northern border is shared with Abuja and Nassarawa State. To the east, Kogi East is bordered by Enugu and Anambra States, while to the south lies Kwara State. The decision to choose a specific zone The rationale for this decision is rooted in the absence of any previous research conducted in the specific region, as well as the limited number of students enrolled in science and technology-related subjects, as shown by the existing literature. One additional factor influencing the selection of this area is the presence of coeducational or mixed-gender schools. In a state of optimal performance. The significance of this matter lies in the fact that gender serves as a moderating variable within the study. The study encompassed a total of 986 senior secondary II science students from both public and private secondary schools within the Kogi East education zone during the 2021–2022 academic year. The study's sample size consists of 430 pupils, with 242 identified as male and 188 identified as female. A multi-stage sampling procedure was employed to choose six (6) senior secondary schools within the designated study area. The researchers employed a multi-stage sampling strategy in order to effectively sample students from the nine local government areas in the Kogi East education zone, specifically

targeting co-educational schools that provide science topics and have qualified science teachers. The study employed the simple random sample technique to choose three local government areas within the Kogi East education zone.

The selected local government areas were Ankpa, Dekina, and Olamaboro. The local government areas under the Kogi East education zone were chosen for the study. The study utilised a purposive sampling technique to choose a total of six schools, with two schools chosen from each of the selected local government areas within the Kogi East education zone. Purposive sampling was employed in this study due to the presence of shared traits among the six selected schools, which distinguish them from other educational institutions. These educational institutions possess a range of attributes that make them highly capable of providing science education, including well-equipped facilities and a team of experienced science educators. Therefore, in this study, the sampling approach involved the utilisation of basic random sampling using balloting and purposive sampling techniques. The data gathering instrument employed in this study was the Scientific and Technology Literacy Test (STLT). The instrument comprised two distinct sections, namely Section A and Section B. Section A focused on gathering personal information from the respondents. Section B consists of two parts. The first part focuses on the content of science and technology education. It includes questions related to science and technology subjects, with multiple choices labelled as A, B, C, or D. The second part addresses the nature of science. In this part, respondents are required to answer "true" or "false" to statements that are categorised into the four levels of scientific and technological literacy being examined.

The questions were organised in such a way that science student levels of scientific and technical literacy, with nominal functions being the lowest level, followed by functional level, structural level, and multi-dimensional level, were tested. The instrument consisted of a test with 40 items, with each level of scientific and technological literacy being addressed by 10 items. The instrument underwent face validation through the involvement of professionals in scientific education, measurement, and assessment from the Department of Scientific Education at Prince Abubakar Audu University in Anyigba, Kogi State. The validation process involved assessing the language proficiency, clarity, and alignment of the instrument with the subject of science and technology, as well as its coverage of the various dimensions of scientific and technological literacy, including nominal, functional, structural, and multidimensional aspects. The instrument underwent modifications, corrections, and deletions based on the feedback provided by the validators. These changes were incorporated into the final draft of the instrument. The dependability of the text instrument was assessed by utilising the outcomes obtained from the trial, known as "instrument testing". The instrument underwent



a trial testing phase, which involved a sample of 20 students from the SSII level who were studying science and technological disciplines.

These students were selected from a co-educational school located in the Ajaokuta local government area. The individual in question is Kuden Richardson. The internal consistency of the instrument was assessed using the reliability coefficient KR20, yielding a reliability score of 0.76. The researchers personally administered the test to the chosen schools and then collected it for scoring purposes. The instrument was administered under controlled examination conditions to mitigate the risk of malpractice. The administration took place during regular class hours, and the responses were collected immediately. The research inquiries were addressed through the utilisation of frequency and percentages, while the chi-square test was employed to examine the null hypotheses at a significance level of 0.05

**Results**

**Research Question One: What are the levels of scientific and technological literacy possessed by science students?**

**Table 1**  
*Frequency and Percentage Rating of Levels of Scientific and Technological Literacy of Students in Science.*

SN	Level of Scientific Literacy	Scores	Mean	Standard Dev.
1	Nominal	328	8.2	0.152
2	Functional	270	6.7	0.331
3	Structure	261	6.5	0.346
4	Multidimension	254	6.3	0.305
	Total	1113	7.0	

Table 1 revealed that majority of the students 328 with mean rating of 8.20 and standard deviation of 0,152 possessed nominal scientific and technological literacy more than the rest. Students 270 with rating of 6.75 and standard deviation of 0,331 are at functional level, students 261 with mean rating of 6,53 and standard deviation of 0,346 are at structural level while students 254 with mean rating of 6-35 and standard deviation of 0.416 are at multidimensional level of scientific and technological literacy. The highest score of 328 with mean of 8.20 indicates that most of the students are at the lowest level of scientific and technological literacy that could not

guarantee the application of scientific knowledge in solving personal or societal problems. the low level of science students' scientific and technological literacy have been attributed to the theoretical teaching of science and technology subjects in school due to lack of instructional facilities , teachers resort to use of taik-chalk approach instead of student centered approach , where teachers teach with demonstration . This can catalyse students' understanding and acquisition of scientific and technological skills (Abuh, 2022).

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

**Table 2**

*One-Way ANOVA of Level of Acquisition of Scientific and Technological Literacy of Science Students.*

Source of Variance	SS	DF	MS	F	SIG OF F
Between groups	460.452	3	153.484	15.244	.0000
Within group	4288.718	426	10.068		
Total	4749.718	429			

\*Significant at  $P < 0.05$  level, Critical Value = 3.75,  $df = 3, 426$

In table 2 shows the calculated f-value of 15.244 is higher than the P-value of 0.05 level of significance with 3 and 426 degree of freedom . With this result the null hypothesis was rejected, thus the null hypothesis was rejected in favor of the alternative. . This result therefore implied that there is a significant difference in the science students' levels of scientific and technological literacy possessed in favor of nominal literacy level

**Research Question2: what is the influence of science and technology subjects on students' level of scientific and technological literacy acquisition.**



**Table 3**

*Mean Rating of Levels of Scientific and Technological Literacy of Science Students Based on Science and Technology Education Subjects*

S/N	Level of scientific and technological literacy	Influence of science and technology educt. education	Scores	Mean	Standard Deviation
1.	Nominal	Physics	65	7.50	0.1924
		Chemistry	81	9.20	0.1520
		Biology	130	14.10	0.1011
		Mathematics	40	5.10	0.1987
			316	9.00	0.1630
TOTAL					

Table 3 shows that the mean rating of total score of science students exposed to science and technology subjects at nominal level is 9.00 and is the highest mean with a standard deviation of 0.1630, at functional level the mean of the total scores of the science and technology subjects is 7.85 with standard deviation of 0.1901, at structural mean of the total score is 6.98 with standard deviation of 0.1965 and at multidimensional level the mean of the total score was 8.25 with standard deviation of 0.1568. Table 3 equally revealed that since the highest mean score is at the nominal level being the lowest scientific and technological literacy level, it however, implies that the students in the zone under this study are at nominal level of scientific and technological literacy. Also the data on table 3 showed that the subject Biology had the highest mean scores across all the levels of literacy. AT nominal literacy Biology had a mean of 14.40 and SD of 0.1011, at Functional level mean was 11.90 and SD was .1420, at Structural level mean was 11.50 and SD was .1424 while at multidimensional level the mean of Biology was 12.50 wih SD of .1341. This implied that Biology had more influence on students' acquisition of scientific and technological literacy than the three other subjects, Physics, Chemistry, & Mathematics. The reason may be because Biology is a core science subject that has been made compulsory for all students in the senior secondary school curriculum as specified in the national policy of education 2004 as amended in 2014. It was also observed that science and technology education has influence on the levels of scientific and technological literacy, as science students were

observed not to only remain at the lower level of literacy, nominal but had second higher mean score at the multidimensional level, showing that with proper and effective science and Technology education delivery, science students can apply their knowledge in solving both their personal and societal problems.

Hypothesis 2: the level of scientific and technological literacy acquisition by students based on science and technology education subjects is not significant

**Table 4:**

*One-way ANOVA of the Influence of Science and Technology Education Subjects on Students' Level of Scientific and Technological Literacy Acquisition.*

Source of Variance	SS	DF	MS	F	SIG OF F
Between groups	392.718	3	130.906	12.776	.0000
Within group	4364.796	426	10.246		
Total	4757.514	429			

\*Significant at  $P < 0,05$  Level , Critical  $F = 3.00$ ,  $df = 3, 426$

The result on Table 4 revealed that the calculated  $f$ -value of 12.776 is higher than the  $p$ -value at 0.05 level of significance with 3 and 426 degree of freedom .with this result the null hypothesis was rejected. in favour of the alternative. This result therefore implied that science and technology subjects have significant influence on students' level of scientific and technological literacy acquisition in favour of nominal level of literacy where the mean rating of biology was found to influence students' acquisition of scientific and technological literacy most than the remaining three other science subjects, physics ,chemistry and mathematics.

**Research Question Three: what is the influence of gender on students' level of scientific and technological literacy acquisition?**

**Table 5**

*Summary of Data and Mean Rating of Scientific and Technological Literacy Acquisition of Science Students Based on Gender*

S/N	Level of scientific and technological literacy	Gender	Score	Mean	Standard Deviation
1.	Nominal	Male	340	8.50	.1568
		Female	190	4.75	.1987
2	Functional	Male	290	7.25	.1724
		Female	200	5.00	.1967
3	Structural	Male	289	7.23	.174
		Female	218	5.45	.1948
4	Multidimensional	Male	286	7.15	.1791
		Female	210	4.75	.1918

Table 5 shows that male science students possessed more nominal with mean of 8.50 and standard deviation of .1568, Functional, mean of 7.25 and standard deviation of .1724, Structural, mean 7.23 and standard deviation .1746 and Multidimensional, mean 7.15 and standard deviation .1791. While the female science students at nominal level had mean of 4.75 and standard deviation of .1987, functional level, mean 5.00 and standard deviation of .1967, structural level, mean 5.45 and standard deviation of .1948, and multidimensional mean 5.25 and standard deviation of .1958. From the result in Table 5, male science students were found to possess scientific and technological literacy more than the female folk, but from the trend, female students' mean rating of acquisition of science and technological literacy was found to be increasing while that of the male students are decreasing .

Notwithstanding, male students possess or have higher mean rating across the four levels of scientific and technological literacy than the female students. However, difference in gender will be clearly shown by the hypothesis.

Hypothesis 3: The level of scientific and technological literacy possessed by students based on gender is not significant.

**Table 6:**One-way ANOVA of level of Scientific and Technological Literacy of Science Students Based on Gender

Source of Variance	SS	DF	MS	F	SIG OF F
Between groups	361.536	3	120.512	9.510	.0000
Within group	5399.846	426	12.671		
Total	5759.382	429			

\*Significant at P, 0’05 level , critical F = 3.32 df 3, 426.

Result on Table 6 revealed that the calculated F- value of 9.510 is higher than the p-value at 0.05 level of significance with 3 and 426 degree of freedom. With the result the null hypothesis was rejected. This result therefore implied that, there is significant difference in the male and female levels of scientific and technological literacy based on gender in favour of the male.

**Discussion of Findings**

The result of this study indicates that there is a significant difference in the science students’ levels of scientific and technological literacy. Students in Kogi East education zone possessed nominal level of scientific and technological literacy followed by functional level, structural level with multidimensional scientific and technological literacy levels. The result equally showed that majority of the science students in this zone possessed nominal level which is the lowest level of scientific and technological literacy. This is agreement with Nwagbo (2006), Baja (2007), Olafalajinc (2009),Ali (2012), Ibe (2013), Obi (2019) and Orji, (2021) opined that most of secondary school students tend to possess lower levels of scientific and technological literacy more than the higher ones. Majority of the students were found to be scientifically and technologically literate at the nominal level while more than half of the students had correct knowledge of scientific and technological literacy at the functional, structural and multidimensional levels, an indication that

students at nominal level are the highest. The level of scientific and technological literacy among the respondents in this study could be attributed to their level of education as their literacy level would increase in scientific and technological exploration which is associated with higher education attainment.

The study showed also that science and technology education subjects have significant influence on the level of scientific and technological literacy possessed by the science students in favour of nominal level, followed by multidimensional level, functional level and least in structural level of scientific and technological literacy. Be that as it may, influence of science and technology education in boosting the knowledge of scientific and technological literacy possessed by respondents of the various levels of literacy could be due to the teaching strategy and instructional method adopted by the teachers for teaching science and technology education subjects. Majority of the students in the study who were scientifically and technologically literate at the nominal level was greatly favoured by the teaching method adopted by the teacher. The finding of this study concurs with Eze, Powell and Trowbridge (2008) and Oji (2021) who opined that students at nominal level have background knowledge of scientific and technological literacy information that can assist the teacher to communicate science and technology education to them easily. The teacher has a group of certain background information that communicators must assume their audiences already have, leading to the adoption of appropriate instructional strategy.

This study equally showed that gender has significant influence on the level of scientific and technological literacy possessed by science students in favour of the male students. Male students had more scientific and technological literacy at all levels compared to the female students. The significant relationship between gender and scientific and technological literacy could be attributed to the fact that male students had interest and positive attitudes towards the study of science and technology education subjects. However, the higher levels of scientific and technological literacy reported among males than females could be due to the fact that males had more confidence in the mastery of science skills compared to the feminine gender who look at science and technology education subjects as masculine discipline. The finding is in agreement with Ibe (2013) reported significant relationship between gender and scientific and technological literacy among secondary school students with male students possessing higher scientific literacy levels than the female counterparts. Also Chris (2018) reported that students literacy skills are influenced by gender differences with males having dominance in most levels. The finding of this study is also in agreement with Aina (2016) who reported that gender has significant impact on students scientific and technological reasoning ability for each construct elucidated in science and technology literacy skills. In contrast Uja (2019) reported that students acquisition

of scientific and technological literacy is not based on gender. similarly result was reported by peter (2019) among secondary school students in Indonesia where there was significant difference between male and female students in three competencies at scientific and technological literacy.

### **Conclusion**

The result of this study revealed that majority of the students in Kogi East education zone possessed nominal level of scientific and technological literacy. The study also showed that science and technology education has great and significant influence on the level of scientific and technological literacy possessed by the students in favour of nominal level followed by functional, structural literacy levels and least in multidimensional scientific and technological level. And finally, gender has significant influence on the levels of scientific and technological literacy possessed by science students in favour of the male folk.

### **Recommendations**

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

1. Scientific and technological literacy gap between sciences students should be bridged by using appropriate teaching strategy that can enhances students' understanding irrespective of their background knowledge.
2. There is need to develop a curriculum of science and technology education capable of inculcate higher levels of scientific and technological literacy, that can enable students posses enough scientific and technological knowledge and skills.
3. Science and technology subject teachers should use gender friendly teaching strategies that encourages equal participation of both gender.

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