Gender and Science-Technology-Society Literacy Level of Secondary School Science Students

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Abstract: *The study was designed to ascertain the influence of gender on the level of Science-Technology-Society (STS) literacy of secondary school science students in Ogoja Education Zone of Cross River State. The study employed a descriptive survey design. A total of 1,200 senior secondary school science students drawn by stratified random sampling technique were used. Two research questions and one null hypothesis guided the study. The instrument for data collection was a 40-item Science-Technology-Society Literacy Scale (STSLS) developed by the researcher. This was validated by experts and reliability coefficient using Cronbach Alpha was found to be 0.79. Data collected were analysed using mean and t-test statistics at 0.05 level of significance. The results showed that male students indicated significantly higher level of STS literacy than their female counterparts in the identified STS literacy clusters. The study recommended amongst others that teachers should adopt the STS literacy approach in the teaching of science and technology. Also, conscious efforts should be made to encourage females to participate actively in science and technology lessons.*

Keywords: Activity-based Methods, Gender, Hands-on Activities, Humanistic Approach, Science Process Skills, Science-Technology-Society (STS) Literacy, Sustainable Development Goals (SDGs).

1. Introduction

Man lives in an ever-changing world which undoubtedly is characterized by increasing scientific and technological innovations. The national and global economies to a large extent depend on science and technology (Wood, 2016). Thus, the survival of any nation depends on the quality of science and technical education available to the citizenry. For instance, countries that have made remarkable impacts in the comity of nations have achieved such feats through broad-based and appropriate science and technical education (Ezeh, 2010; Aribido, 2016). Therefore, for adequate implementation of the United Nations' Sustainable Development Goals (SDGs) in Nigeria, it is imperative that the citizenry, both male and female, have substantially greater understanding of the remarkable interdependence between science, technology and the society and are able to effectively exploit this relationship in their approach to issues.

Unfortunately, the content of science and technical education taught in Nigerian schools seems to be devoid of local environmental input. As Ogwuazor in Agbi (2018) stressed, the time is now ripe to think about and evolve an approach which will centre round the utilitarian value of science and technology in terms of human needs. Such an approach should also be able to adequately involve both male and female in the teaching-learning process. This underscores the need to effectively use science-technology-society (STS) issues in a humanistic approach in science and technical education classrooms aimed at the learners' adequate acquisition of STS literacy.

STS as an emerging, complementary and innovative paradigm shift in the teaching and learning of science and technical education deals with three main areas of human endeavours – Science (man's natural world), Technology (man's artificial world) and Society (man's social world). According to Yagar and Yager cited in Agbi (2018), the capability of individuals to make crucial decisions about current problems and issues in the society and take personal actions as a result of the decisions based on their level of awareness of the importance, applications, basic concepts and relationship between science, technology and society is termed STS literacy. This approach to teaching and learning demand that both the students (male and female) and their teachers work co-operatively together. The lessons should always be geared towards solving real life issues confronting the students, the local community or the public at large. The utilitarian values of science and technology are usually stressed in the classroom for their impacts to be felt in the society. According to Zoller (2013), this demands adequate resourcefulness on the part of the teacher and learners. This makes the learning to be more responsive to the needs of human society and not for mere acquisition of facts for their sake. Thus, it is obvious that acquisition of STS literacy is a major requirement in transforming the world, especially in Nigeria and other developing nations where there is still high level of ignorance, diseases, poverty and unemployment (Igbaji, Miswaru & Sadiya, 2017). It is a high hope and one major educational reform approach that can help in the attainment of the United Nation's Sustainable Development Goals (SDGs) in Nigeria by the year 2030.

For the SDGs to be achieved, everyone needs to do his part, irrespective of gender. Appropriate education such as STS literacy that guarantees a high degree of scientific and technological literacy on the learners and ultimately on the entire populace is vital for the realization of these goals (Ojebiyi & Fasakin, 2014). Thus, the science teacher has a major role to play in ensuring that the learners (both male and female) and the general populace have the requisite knowledge, skills and attitudes in actualizing the United Nations' SDGs.

Naturally, great differences exist between male and female. These differences emanate from the biological differences and the differences in the socio-cultural demands on male and female (Sonnert & Fox, 2012; Almut, 2017). These differences are likely to have a marked effect on the

acquisition of science process skills by male and female students if appropriate measures such as the STS literacy approach and other similar activity-based methods are not adequately adopted in the science and technology classrooms. Similarly, teachers' implicit stereo-types can contribute to gender differences in motivational beliefs as well as gender educational choices (Almut, 2017). The issues of gender stereo-typing in science and technology-based career choice and practice are prevalent in the society. For instance, males are more likely than females to be employed in science and technology-based fields in the society (Sonnert & Fox, 2012). If this continues, it means that a significant percentage of females are likely to be excluded from active participation in the implementation of the Sustainable Development Goals (SDGs). However, this can be corrected by the acquisition of enhanced STS literacy by the females just like their male counterparts.

In clear terms, therefore, STS literacy is a *sine qua non* for effective participation of individuals in the implementation of the SDGs. Hence, the need to assess the level of STS literacy possessed by male and female secondary school science students in Ogoja Education Zone of Cross River State.

2. Statement of the Problem

Today's world is driven by scientific and technological innovations and discoveries. For the individuals to adequately live and thrive in this ever-changing world there is need for adequate acquisition of scientific, technological and environmental knowledge, skills and attitudes, which to a large extent should be based on the inter-relationships between science, technology and the society.

The United Nations' Sustainable Development Goals aimed at ending poverty, protecting the environment and ensuring prosperity by the year 2030 cannot succeed without adequate bases in STS literacy. Thus, the school has a major role to play in realizing the set goals. The level of STS literacy of both male and female learners will invariably determine the level to which the SDGs will be achieved in the society. It is against this background that the need to ascertain the level of STS literacy of both male and female secondary school science students has become imperative.

3. Purpose of the Study

The purpose of this study was to ascertain the level of STS literacy of secondary school science students by gender in Ogoja Education Zone of Cross River State. Specifically, the study was designed to:
1) Determine the level of STS literacy of secondary school science students.
2) Determine the level of STS literacy of secondary school science students by gender.

Research Questions
Two research questions were posed for the study:
1) What is the level of STS literacy of secondary school science students in Ogoja Education Zone of Cross River State?

2) What is the level of STS literacy of secondary school science students in Ogoja Education Zone of Cross River State by gender?

Research Hypothesis
The following hypothesis was tested at 0.05 level of significance:
1) There is no significant difference between the mean STS literacy level of male and female secondary school science students.

Research Design
The study employed a survey research design using a structured questionnaire. This design was adopted since the study merely sought information from the respondents as the situation exists in the study area.

The population of the study consisted of all the senior secondary school science students in the study area. This population consisted of male and female senior secondary school science students in the five Local Government Areas of Ogoja Education Zone. In each of the five Local Government Areas, eight schools were selected using stratified random sampling technique. This gave a total of 40 secondary schools. From each school, 30 SS III science students were selected using purposive sampling technique. Hence, a total of 1,200 SS III science students served as sample for the study (i.e. 40 x 30 = 1,200).

The total numbers of male and female science students were 750 and 450 respectively. The SS III students were selected for this study because based on the school curriculum, it is expected that this category of students should have been fully exposed to all the rudiments of STS in the school programme.

Instruments for Data Collection
The instrument used for the study was a structured questionnaire – the Science-Technology-Society Literacy Scale (STSLS) for students which was developed by the researcher based on extensive review of related literature. This 40-item instrument was validated by six experts – four experienced science educators and two experienced experts in test and measurement from both the Colleges of Education and Universities. The instrument was a four-point Likert-type Scale divided into four clusters of STS literacy – Knowledge, Application, Communication and Appreciation of STS. The response options on the scale were Strongly Agree (SA), Agree (A), Disagree (DA) and Strongly Disagree (SD). Items were scored 4, 3, 2 and 1 respectively for all positive statements and the reverse for all negative statements. The respondents were requested to indicate their level of agreement or disagreement with each statement in the various clusters (or areas) of the questionnaire. Internal consistency reliability co-efficient of STSLS was established to be 0.79 using Cronbach's Co-efficient Alpha. This was considered high enough and reliable.

4. Data Analysis and Results

Data collection from the sample was carried out by the Researcher and five Research Assistants. The data was analysed using mean and t-test statistics in accordance with

the research questions and hypotheses. The mean performance levels were determined and interpreted as follows:

Above 3.50 means Adequately STS literate
2.50-3.50 means Moderately STS literate
Below 2.50 means Not STS literate

In specific terms, Mean was used to answer the research questions while t-test statistics was used to test the hypothesis, in order to determine significance of the difference between the mean performance scores of the male and female respondents.

The results of the analysis are as summarized in the following tables (1-2).

Research Question 1

What is the level of Science-Technology-Society (STS) literacy of secondary school science students in Ogoja Education Zone?

Table 1: Mean Scores of Secondary School Science Students (By gender and overall) in the STSLS, N = 1,200

S/N	STSLS Clusters	Male $\overline{X}$	Female $\overline{X}$	Overall $\overline{X}$
1	Knowledge of Science, Technology and Society	3.70	3.18	3.44
2	Application of Science and Technology in the Society	3.56	2.28	2.92
3	Communication of Science and Technology in the Society	2.24	2.72	2.48
4	Appreciation of Science and Technology in the Society	2.46	2.30	2.38
	Overall	2.99	2.62	2.81

Table 1 above shows the mean scores of the respondents in the various clusters of STSLS. The mean scores in the various clusters are as follows – Knowledge (3.44);

Application (2.92); Communication (2.48); Appreciation (2.38) and Overall (2.81). Since the cluster mean scores for Communication and Appreciation are below the mean of 2.50, these indicate that the respondents are not STS literate in these areas. However, the mean scores for Knowledge and Application are within the mean range of 2.50-3.50, these are indicative that the respondents are moderately STS literate in these areas. Similarly, the Overall mean is within the mean range of 2.50-3.50. Hence, it can be concluded that the respondents are moderately STS literate.

Research Question 2

What is the level of STS literacy of secondary school science students in the Ogoja Education Zone of Cross River State by gender?

Table 1 data shows the comparison of two group means (male and female students) on STSLS Clusters – Knowledge (3.70 Vs 3.18); Application (3.56 Vs 2.28); Communication (2.24 Vs 2.72); Appreciation (2.46 Vs 2.30) and Overall (2.99 Vs 2.62). Since the cluster means in the areas of Knowledge and Application for the male students are above 3.50, these are indicative that the male students are adequately STS literate in these areas. However, they are not STS literate in the areas of Communication and Appreciation of STS as their mean scores are below 2.50.

For the female students, they are moderately STS literate in the areas of Knowledge and Communication of STS (Mean scores are within the range of 2.50-3.50). However, they are not STS literate in the areas of Application and Appreciation of STS (mean scores are below 2.50). In the overall consideration, the Overall mean scores of both male and female students are within the mean range of 2.50-3.50. These are indicative that both male and female students are moderately STS literate.

Hypothesis 1: There is no significant difference between the mean STS literacy level of male and female secondary school science students.

Table 2: The t-test of the Mean Rating of STS Literacy Level of Male and Female Secondary School Science Students, N = 1,200

	Mean	SD	n	Df	Std Error	t-cal	t-crit	Decision
Male Students	2.99	0.76	750	1,198	0.06	6.17	1.96	Reject Ho
Female Students	2.62	1.03	450					

Where SD = Standard Deviation, t-cal = t-calculated and t-crit = t-critical (table value).

Table 2 above presents the t-test analysis of the difference between the mean rating of STS literacy levels of male and female secondary school science students in the identified literacy clusters. From the table, it can be observed that the t-calculated (6.17) at 1,198 degree of freedom (df) and 0.05 level of significance is greater than the t-critical (table value) of 1.96. There is therefore, enough evidence to reject the null hypothesis (Ho) of no significant difference. Male students performed significantly better than their female counterparts. Hence, gender is a significant factor in the level of STS literacy of secondary school science students in the study area.

The above analysis of data has resulted into the following findings:

1) Secondary school science students indicated moderate level in STS literacy.
2) In specific terms, both male and female secondary school science students indicated moderate levels in STS literacy.
3) Male students indicated significantly higher level of STS literacy than their female counterparts.

5. Discussion of Findings

The finding that secondary school science students are moderately STS literate is in line with the earlier finding of Ogunniyi, Eniayeju and Emeriole cited in Agbi (2018) that the conditions in which scientific/technological literacy programme operates in schools are very unsatisfactory. They

assert that less than one-third of the necessary requirements for its proper functioning had been met. In this not commendable performance of the science students in STS literacy, some specific areas are the most challenging. These are Communication and Appreciation of science and technology in the society.

There is a dire need, therefore to consciously familiarize students with these areas of STS literacy to enable them contribute meaningfully to the society. This is very vital for the successful implementation of the SDGs in Nigeria. Thus, the science teacher and the government have a major role to play in ensuring that the learners (both male and female) and the general populace have the requisite knowledge, skills and attitudes in actualizing the United Nations' SDGs.

Another finding of the study is that male students have significantly higher level of STS literacy than their female counterparts. This implies that gender is a significant factor in the level of acquisition of STS literacy of individuals. This is however not in agreement with the earlier finding of Abdullahi, Abubakar, Abubakar & Aliyu (2019). This difference emanated mainly in the area of Application of science and technology in the society where the mean rating of the females was as low as 2.28 (table 1). This is not surprising since most females unlike their male counterparts usually perform poorly in the areas involving hands-on activities. This is in line with the assertions of Sonnert & Fox (2012) and Almut (2017) that great differences exist between male and female. That these differences emanate from the biological differences and the differences in the socio-cultural demands on male and female. These differences are likely to have a marked effect on the acquisition of STS literacy by male and female students.

The acquisition of science process skills is of utmost importance in science-technology-society education. This means that STS learning, irrespective of gender requires the development of rational critical thought process in the students to enable them explore, discover, invent and develop some of the tools of inquiry appropriate to the field of science (Ebere, 2006; Ojebiyi & Fasakin, 2014). This can only be realized by the continuous and effective efforts of the teacher. It therefore follows that for effective and efficient attainment of global sustainable development in any society, equitable harnessing and maximizing of the human resources irrespective of gender is necessary. Since females are known to have high creative power and equal intellectual assets with males (Ezeh, 2013), they should be equally and consciously empowered through appropriate education in STS to fast-track sustainable development of the human society.

6. Conclusion and Recommendations

The results of the study have shown the level of STS literacy of secondary schools science students. Although male and female students indicated moderate level of STS literacy, this was however in favour of the male students. Specifically, there is a significant difference between the level of STS literacy possessed by male and female students. It can be concluded therefore that gender is a significant factor in the

acquisition of STS literacy among secondary school science students.

In view of the educational implications of the findings, the following recommendations are made with a view to realising enhanced national development:
1) Science and technology teachers should always strive to employ appropriate methodology (STS literacy approach/activity-based method) in teaching science and technology in schools since this will help immensely in enhancing the STS literacy level of their students.
2) The current curriculum for science and technology education should be redesigned to adequately emphasize the inter-relatedness of science, technology and society.
3) Adequate opportunities should be given to female science students in terms of encouragement through adequate provision of teaching and learning resources in the science and technology classrooms.

7. Financial Support

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