# INVESTIGATING THE SCIENTIFIC LITERACY OF PRE-SERVICE SCIENCE TEACHERS IN ENUGU STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY, ENUGU STATE

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**Abstract**
The study investigated the Scientific Literacy of Pre-Service Science Teachers in Enugu State University of Science and Technology. The study was guided by two research questions. Descriptive survey research design was adopted for the study. The total population of the study was 427. This consisted of all the pre-service science teachers of Science Education Department, Faculty of Education, Enugu State University of Science and Technology. Using simple random sampling technique, a sample size of one hundred and twenty (120) pre-service science teachers was drawn, while purposively sampling was used to select 30 undergraduate students per academic level, to ensure for an even selection across all levels in the department, and to eliminate bias in relation to items response. The instrument for data collection was a structured Pre-service Science Teachers Scientific Literacy Questionnaire (PSTSLQ), with clustered 35-item questions arranged systematically based on the research questions. The instrument was face and content validate by three experts. There was no reliability test since the items were chiefly standardized. Copies of the instrument were distributed to the respondents, and the pre-service science teachers were requested to submit the completed distributed questionnaire at the spot. This was done in order to ensure 100% return rate. The data collected was analyzed using mean score and standard deviation. The decision rule for interpreting the results was based on the calculated means. Responses on each of the research question were considered high/agree and accepted when the mean is 2.50 and above, and low/disagree and rejected when less than 2.50. Findings from the analysis made revealed that pre-service science teachers in ESUT: are scientifically literate; and have a satisfactory perception on the indices of scientific literacy. Based on the findings of the study, the researcher recommended that: measures should be adopted to improve the level of scientific literacy of pre-service science teachers: this could be through a pedagogical shift to constructivists-based learning, pedagogical teaching amongst others.

**Keywords:** Science, Scientific Literacy, Pre-service Science Teachers,

## Introduction

Education is an instrument "par excellence" for effective national development. The development of any nation depends largely on the level of education attained by her citizens especially in the area of science and technology. It is highly rated as the most important instrument of change since any definite change in the intellectual and social outlook of the people must be preceded by an educational revolution. Thus, from the ancient time, human beings have experimented with materials in their environment to feed, clothe, transport and

shelter themselves (Ababio, 2013). What started as a satisfaction of human basic needs has now developed into "Science". Science however, has been severally defined by different authors and researchers. It is: a tentative knowledge gained through systematic and procedural processes, which include observations and experimentation (Aniodoh, 2019); a complex structure of many related disciplines, whose development depends on the scientist's imagination and his deep desire to understand his world (Gardner, 2014); all human activities involving organized knowledge of natural phenomena (Hyacinth, 2015). Eze (2013) noted that science is a special type of discipline and field of study with peculiar characteristics such as objectivity, systematic reliability, observability, empirical verifiability, ethical neutrality and malleability. In addition to the outlined characteristics, it is an approach through which knowledge is pursued. This approach is commonly known as scientific method. It is a logical, rational and systematic process by which knowledge in the discipline and field of study is pursued and conclusion about nature around them derived; Mbajiorgu, (2018) in her work noted that science is the study of natural occurrence or way of making sense of the natural physical world. Mbajiorgu further revealed that there cannot be any meaningful development without science. This is in agreement with the notion of Nwachukwu (2015) which reported that the development of the nation depends on the level of scientific teaching and knowledge received by individuals.

From the above explanations, science in a nutshell can be seen as a field of study which involves a systematic process of carefully investigating and obtaining knowledge about nature and its phenomena. This knowledge when fully acquired is fit to develop scientifically literate individuals with high competence for rational thought and action, which by implication will bring about national development. Thus, science is a continuing effort to discover and increase knowledge that brings about national development through research. Hence, through research, scientists make observations and analyze the information at hand to construct theoretical explanations of the phenomena involved. To ensure however, the effective teaching and learning of sciences in Nigerian context, the teaching and learning of sciences are geared towards the attainments of some objectives which include:

1. develop literate individuals scientifically;
2. develop a high competence for scientific and reflective thinking;
3. develop sound scientific attitude in individuals;
4. give scientific education as a basis for effective participation in and contribution to the society;
5. develop and adapt to the changing environment;
6. develop intellectual and vocational competence (Federal Ministry of Education, 2014).

Based on the above-referenced objectives, it could be summed up that the teaching and learning of sciences is aimed at developing scientific literacy in the learners with the expectation that the teachers or instructors, as the case maybe, are already scientifically literate. However, the scientific literacy of teachers especially that of science teachers are still below expectations (Ani, Egbe & Ugwu, 2022). The authors revealed that one of the factors contributing to the poor performances of students in the subject in secondary schools is the dearth of qualified teachers. In disagreement to the above result, Aniekwe and Ikechebelu (2021) found that the qualification status of science teachers in Enugu state are adequate with the minimum requirements. This, therefore, calls for the need to review the scientific literacy status of science teachers in Enugu state. Since today's pre-service teachers are tomorrow's serving teachers, it is necessary to begin the investigation from the pre-service teachers.

Based on the foregoing, one would be prompted to ask; what is scientific literacy? Scientific literacy encompasses written, numerical, and digital literacy as they pertain to understanding science, its methodology, observations and theories. Aniodoh (2018) defines scientific literacy as the understanding of the various elements of scientific processes and potential controversies surrounding the application of such concepts. Scientific literacy includes the application of science in cultural, political, social, and economic issues. The issue of scientific literacy has become increasingly important in education. Schools now favour student learning through inquiry-based learning rather than through fact memorization. This means that understanding the process of science and application of scientific concepts is the center goal. In relation to this study which is on the scientific literacy status of pre-service science teachers, the researcher sought to ascertain how far pre-service teachers are capable of engaging in reasoned discourse about science and technology which requires some scientific competencies. It is therefore necessary to pose the question: who is a pre-service science teacher?

Pre-service science teachers are known as teacher candidates or student teachers who are enrolled in a teacher education program and working toward teacher certification in various science subjects. They complete supervised field-based teaching experiences with the support and mentorship of university faculty. They are trained from higher education institutions to become professional teachers. Since scientific literacy includes being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another; understanding some of the key concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations; and being able to use scientific knowledge and ways of thin king for personal and social purposes.

According to the United States National Center for Education Statistics, "scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. A scientifically literate person is defined as one who has the capacity to:

- Understand, experiments, and reason as well as interpret scientific facts and their meaning.
- Ask, find, or determine answers to questions derived from curiosity about everyday experiences.
- Describe, explain, and predict natural phenomena.
- Read articles with understanding of science in the popular press and engage in social conversation about the validity of the conclusions.
- Identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed.
- Evaluate the quality of scientific information on the basis of its source and the methods used to generate it.
- Clarify inconsistencies in scientific knowledge
- Clarify scientific misconceptions.

Considering the impact of scientific literacy around the world today, it is very vital that the pre-service science teachers (student teachers or teacher candidates) level of scientific literacy be shored up. This is to enable them, when faced with problems, to try their best to explain the phenomenon surrounding that problem and then use their scientific knowledge to tackle the problem. It will also impact on the students that will be trusted into their care when they move into the field.

Furthermore, knowing how the level of scientific literacy possessed by these students in relation to their achievements is very crucial. Determining such relationships can influence the strategies adopted by faculty when teaching the pre-service science teachers. The impact of scientific literacy indices on pre-service teacher's science achievement makes them to know their stand when it comes to science and solving problems, this will lead to the pre-service teacher going extra-mile just to fill that gap they felt might be missing in their knowledge. When it comes to their future careers which is teaching, it is important to know the level of the influence of scientific literacy indices because in order to inculcate in their students the scientific knowledge and method, they must be very conversant with the scientific literacy indices and must have constantly applied it in solving problems in the presence of their students. Hence, the present study investigated the level scientific literacy pre-service science teachers in Enugu State University of Science and Technology (ESUT), irrespective of their gender.

**Problem Statement**

Evident in the reviewed literature, is that the level of scientific literacy of pre-service science teachers is quite understudied which creates the need for this study. It was also documented that scientific literacy plays an important part in the achievement of students and may form an important part in how teachers view and teach the sciences. It is, therefore, necessary to investigate the scientific literacy of pre-service science teachers as well as its impact as a predictor of students' achievements in the subject. Thus, the problem of this study is posed as a question: what the level of scientific literacy of pre-service science teachers in Enugu State University of Science and Technology is?

**Research Questions**

The following research questions guided the study:

1. What is the level of scientific literacy possessed by pre-service science teachers in ESUT?
2. What are the pre-service science teachers' perceived indices of scientific literacy in ESUT?

**Methodology**

A survey design was adopted for the study. A survey design, according to Nworgu (2015) is a design where peculiar characteristics of a known or identified population are studied through a sample, which is deemed to be representative of the population. Such study is only interested in describing certain variables in relation to the population. Ojo (2019) opined that survey is the best technique for obtaining the necessary data from a group in which the sample drawn from the population and their opinion will be used to generalize the opinion of the entire population. This design was appropriate for the study because; it collected data and described in a systematic manner, the scientific literacy of pre-service science teachers in Enugu State University of Science and Technology. The study was carried out in Science Education Department, Faculty of Education, Enugu State University of Science and Technology. Science Education has a total number of four (4) different areas of discipline (options) namely: Biology, Chemistry, Physics and Integrated Science options. The population of the study consisted all the 427 undergraduate students in the Department of Science Education, across the four programme options, while a sample size of 120 undergraduate students was drawn from the population of the study. Purposively, the researcher selected 30 undergraduate students per academic level, to ensure for an even selection across all levels in the department, and to eliminate bias in relation to items response.

A 35-item questionnaire titled "Pre-service Science Teachers Scientific Literacy Questionnaire (PSTSLQ)", was designed by the researcher in line with research questions that guided the

study and was used for the data collection. The questionnaire consisted of two parts. The first part contained the respondent's personal data while the second part encompassed a list of the items raised to answer the research questions. The items of the questionnaire were structured to have four points' scales of: Strongly Agree (SA), Agree (A), Disagree (D). Numerical values of 4, 3, 2 and 1 were given to the options respectively in each line of scale. The Instrument was subjected to face and content validation. The instrument was validated by three experts, two from Science Education Department, and one from Mathematics and Computer who majors in Measurement and Evaluation, all from Faculty of Education, Enugu State University of Science and Technology, ESUT). The validators made some comments which formed the basis for the modification of the items before using it. The data were collected by the researchers and were analyzed using mean scores and standard deviation. Therefore, the decision rule for interpreting the results was based on the values of the calculated means. Responses on each of the research questions were considered high/agree and accepted when the mean is 2.50 and above, and low/disagree and rejected when less than
2.50 for research 1 and 2 respectively.

**Results**

**Research Question 1:** What is the Level of Scientific Literacy Possessed by Pre-Service Science Teachers in ESUT?

**Table 1: Mean and standard deviation response scores of respondents on the level of Scientific literacy of undergraduate Science students in ESUT**

| Variable | N | Mean | SD | Decision |
|---|---|---|---|---|
| Scientific Literacy | 120 | 3.52 | 2.30 | High Level |

Data in Table 1 answered research question one which sought to find out the level of scientific literacy possessed by pre-service science teachers in ESUT. The table revealed that the mean scientific literacy score of pre-service science teachers is 3.52. This mean score is greater than 2.50 benchmark mean score as set by the researcher, hence the level of scientific literacy possessed by pre-service science teachers in ESUT is on the high level. The computed data also showed a small value of standard deviation of 2.30, which indicated that the scores of the students are clustered around the mean. Hence, homogeneous and true presentation of their actual scores.

**Research Question 2:** What are the Pre-Service Science Teachers' Perceived Indices of Scientific Literacy in ESUT?

**Table 2: Mean response scores of respondents on the perceived indices of scientific literacy by pre-service teachers in ESUT**

| SN | Pre-service teachers perceived indicators of scientific literacy | SA | A | D | SD | Mean | STD | Dec. |
|---|---|---|---|---|---|---|---|---|
| 25 | Scientific literacy brings about sound knowledge of scientific experiments | 104 | 15 | 1 | 0 | 3.86 | 0.37 | Agree |
| 26 | Scientific literacy builds in the teachers the ability to interpret scientific facts and their meaning | 112 | 8 | 0 | 0 | 3.93 | 0.25 | Agree |
| 27 | Scientific literacy builds ability to describe and explain, natural phenomena | 90 | 30 | 0 | 0 | 3.75 | 0.43 | Agree |
| 28 | It brings about the ability to predict natural phenomena | 80 | 39 | 1 | 0 | 3.66 | 0.49 | Agree |
| 29 | Scientific literacy helps to clarify scientific misconceptions | 71 | 49 | 0 | 0 | 3.59 | 0.49 | Agree |
| 30 | It helps to clarify inconsistencies in scientific knowledge | 60 | 58 | 2 | 0 | 3.48 | 0.53 | Agree |
| 31 | It builds up the ability to evaluate the quality of scientific information on the basis of its source and the methods used to generate information | 68 | 51 | 1 | 0 | 3.56 | 0.52 | Agree |
| 32 | It brings about sound knowledge of scientific attitudes | 56 | 62 | 2 | 0 | 3.45 | 0.53 | Agree |
| 33 | Scientific literacy encourages sound understanding of science process skills | 55 | 61 | 4 | 0 | 3.43 | 0.56 | Agree |
| 34 | It brings about sound understanding of science product skills | 48 | 66 | 6 | 0 | 3.35 | 0.57 | Agree |
| 35 | ability to identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. | 55 | 62 | 3 | 0 | 3.43 | 0.55 | Agree |
| | **Grand Mean** | | | | | **3.59** | **0.52** | **Agree** |

Data In Table 2 which answered research question two that sought to find out the pre-service science teachers' perceived indices of scientific literacy. From the data computed in the above table, the respondents agreed to all the items with mean scores greater than 2.50, which is the mean benchmark set for the study. This shows that all the items 25-35 such as sound knowledge of scientific experiments, ability to interpret scientific facts and their meaning, ability to describe and explain, natural phenomena, ability to predict natural phenomena among others as shown in Table 2 above are indices of scientific literacy as perceived by pre-service science teachers. In the same vein, the responses of the respondents in the Table above show small values in their respective standard deviation scores, which indicated that the scores of the students are clustered around the mean. Hence, homogeneous and true presentation of their actual scores.

In addition, items 25-35 had overall grand mean of 3.59 which is higher than 2.50 benchmark set for the study hence, the respondents agreed that items 25-35 contained in the table above are indices of scientific literacy as perceived by pre-service science teachers. In the like manner,

the 0.52 overall standard deviation score is an indication that the schools of the respondents are clustered around the mean. Hence, homogeneous and the true presentation of their actual scores.

**Discussion of Findings**

Findings in Table 1 relates to research question one, which was aimed at determining the level of scientific literacy possessed by pre-service science teachers in ESUT. The computed data in Table 1 showed that the level of scientific literacy possessed by pre-service science teachers in ESUT is on the high level. This result is quite in agreement with the findings of Flores (2019) which stated that pre-service science teachers have high scientific literacy level in areas such as nature of science, science technology and the society, and science content knowledge. It is thus, summed up that the scientific literacy level of the pre-service science teachers in ESUT is satisfactory.

Research question 2 was aimed at determining the pre-service teachers' perceived indices of scientific literacy. Data computed in Table 2 above showed that the pre-service science teachers agreed that the indicators of scientific literacy include: possession of scientific attitudes, ability to interpret scientific facts and their meaning, sound knowledge of science experiments among others. The result above is in consonance with the findings of Ukattah (2019) which stated that the indicators of scientific literacy are the possession of science process skills, knowledge, attitude and experimental skills. Based on the aforesaid, pre-service science teachers have a satisfactory perception on the indicators of scientific literacy.

**Conclusion**

The results of the analyzed data were used to answer the research questions. The answers to the research questions, therefore, gave a detailed report on the scientific literacy level of pre-service science teachers in Enugu State University of Science and Technology, ESUT, Enugu State. As an outcome of the investigation, it was identified that: **t**he level of scientific literacy possessed by pre-service science teachers in ESUT is on the high level; it was also, revealed from the findings of the study that respondents are in agreement that all the outlined items such as sound knowledge of scientific experiments, ability to interpret scientific facts and their meaning, ability to describe and explain, natural phenomena, ability to predict natural phenomena among others are indices of scientific literacy as perceived by pre-service science teachers in Engu State University of Science and Technology.

**Recommendations**

Based on the findings of the study, the researcher made the following recommendations:

1. Measures should be adopted to improve the level of scientific literacy of pre-service science teachers. This could be done through the followings

a. a pedagogical shift to constructivists-based learning.

b. provision of teaching resources to support constructivist-based learning.

2. Lecturers should ensure that all the perceived indices of scientific literacy be properly taught at all academic levels of pre-service science teacher.
3. Government should ensure the conducting of seminars, conferences, workshops etc for training of pre-service teachers in core and science related disciplines.

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