Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.14, No.11, 2023

Senior High School Students' Scientific Literacy: A Case of an Urban and a Rural School in Ghana

Rebecca Esi Quansah
Department of Integrated Science Education, University of Education, Winneba, Ghana
*esibeckles@yahoo.co.uk

Abstract
This study assessed the scientific literacy level of senior high school students in a rural and an urban school in Ghana. One hundred and fifty-six students were assessed using the Nature of Science Literacy Test (NOSLiT) which was developed by Wenning (2006) and focused group discussion. Data from the NOSLiT were analysed descriptively and findings from the focused group discussion were presented and discussed along six frameworks. The study revealed that most students in Ghana showed low scientific literacy level, however, students (mean score of 16.19) in the urban school showed a higher scientific literacy level than their counterparts (mean score of 15.03) in the rural school. However, there was no statistical significance difference in the performance of students across school location. NOSLiT is best used as a research instrument for identifying weaknesses in student understanding, improving instructional practice, and determining program effectiveness. It is therefore hoped that the results of this study will persuade science teachers in the Senior High Schools to employ the enquiry processes of Science teaching (MoESS, 2010) as stipulated in the science syllabus. If Ghana have to achieve quality science education.

Keywords: Scientific literacy, Senior High School, Urban, Rural
DOI: 10.7176/JEP/14-11-04
Publication date: April 30th 2023

1. Introduction

Scientific literacy has been variously defined over time by many authors. According to Durrant (1993) as cited Nuangchalerm, (2010), scientific literacy is what people should be aware of when it comes to science. Jenkins (1994) defined scientific literacy as having some acquaintance with the more important scientific concepts as well as an awareness of the nature, purposes, and general limitations of science. Science literacy describes the ability of an individual to understand scientific laws, theories, phenomena and things (Dragoș & Mih, 2015). Brewer (2008), who made this assertion more recently, characterized scientific literacy as having the ability to read anything in a newspaper or magazine, listen to comments on the radio or television, and understand what is being said while also being able to be skeptical. He continued by saying that you can only assess whether the information being offered to you is truthful and fair if you have a fundamental understanding of science. Scientific literacy includes understanding fundamental natural science concepts as well as how science relates to math, technology, and other human endeavours. It also includes knowledge of the nature of science and analytical skills such as designing experiments, collecting and analyzing data, and drawing valid inferences from the evidence (Ogunkola, 2013). Dragoș and Mih (2015) further added that scientific literacy represents the ability to use evidence and data to evaluate the quality of the information and arguments presented by the scientists and, in mass media. It is essential to teach science to all citizens in our contemporary, technologically and scientifically advanced society, not simply to those who are actively interested in it or who choose it as their early career. A crucial part of schooling according to McPhearson, et al. (2008), is scientific literacy. Only nations with a sufficient level of scientific literacy, according to Laugksch (2000), will be able to sustain a steady supply of scientists, engineers, and technically proficient workers. In support of this claim, Walberg (1983) suggested that scientific literacy will improve people's ability to make informed decisions when participating in the productive sector of the economy. He got to the conclusion that scientific literacy needs to be considered a kind of human capital that has a number of advantageous implications on a nation's economic well-being. However, scientific literacy does directly influence people's lifestyles. Anyone who lives in a culture that values science and technology benefits from having a greater understanding of these subjects, claims Durant and Thomas (1989). They also think that persons who are better informed may be able to function in society more successfully. Such as practicing productive agriculture, improving sanitation practices, live a healthy lifestyle, optimizing energy resources, reduce pollution, manipulate simple technological objects, among others. Lewenstein (2003) provided a number of arguments for the importance of scientific literacy and the necessity of our being concerned about people's understanding of science. The first argument concerning civics is that everyone should have some level of scientific literacy since public concerns are addressed with some scientific grounding. For instance, everyone in the community should be aware of the need to remove weeds from around crops.

Ghana, like the other developing countries in Africa, has many issues concerning undernourishment, poverty, sickness, illiteracy, a short life expectancy, and lack of industry. The nation recognized that the key to overcoming these issues lay in science and technology education. Early in the 1960s, the Government of Ghana implemented economic and educational programs that extended access to education (Anamuah-Mensah, 1994). The development of industry in both urban and rural areas, as well as the education of science, was prioritized. The decision to train engineers, architects, and scientists to work in these fields led to the creation of the University of Science and Technology. To steer human resource development in the direction of science and technology, the Government of Ghana instituted scholarship scheme. Scholarships for science studies were simple to obtain. Incentive awards were given to science teachers at the universities and secondary schools. During that time, a deeper connection was sought between the science subjects taught in schools and the cultural practices of the populace, their environment, and places of employment (Anamuah-Mensah, 1998). The causes of the current situation of science education have been commented upon by numerous Ghanaian researchers (See for example, Anamuah-Mensah, 1994; 1998, Towse, Anamuah-Mensah, Mushi, & Kent, 2005; Fredua-Kwateng & Ahia, 2005). After many years of independence, despite different steps taken by successive governments, including policies and programs, not much has been accomplished in the efforts to improve the country through science and technology education. Ghana continues to struggle with underdevelopment. Disease outbreaks, unkempt environments, and environmental degradation are frequent occurrences. It is obvious that using science and technology education as a means of promoting Ghana's development has not been particularly effective. The situation demands an enquiry on “how much” science the citizens acquire at a particular stage in life or level of education. Students' scientific literacy can be evaluated by using Nature of Science Literacy Test (NOSLiT) developed by Wenning in 2006. The Wenning-developed Nature of Scientific Literacy Test (NOSLiT) is an evaluation tool that consists of 35 items consisting of the following frameworks: science nomenclature, experimental ability and basic observation, rules of scientific evidence, scientific postulate, scientific disposition, and major misconception about science. The six frameworks are designed to assess learners' proficiency in Senior High School science. According to Wenning (2006), science-literate people are those who are familiar with the six NOSLiT frameworks. The NOSLiT's content is closely related to Ghana's Integrated Science curriculum for Senior High School students. As a result, the NOSLiT is highly valid for use as a tool to assess students' scientific literacy in Ghanaian Senior High Schools. The goal of the Integrated Science curriculum is for students to be able to solve basic scientific problems in their immediate environment through analysis and experimentation as well as to adopt a scientific way of life based on pragmatic observation and investigation of phenomena through the enquiry process (MoESS, 2010).

The NOSLiT has been used by numerous studies over the years to evaluate students' scientific literacy, with varying degrees of success. Using NOSLiT indicators, Rahayu, Masykuri, and Soeparmi (2018) examined the scientific literacy skills of physics teachers in vocational schools. The test instrument yielded the following results: Scientific Nomenclature, 38.46%; Basic Experimental and Observational Skills, 38.46%; Rules of Scientific Evidence, 0%; Postulate Science, 15.38%; and Scientific Attitude, 7.69%. Each indicator's outcome demonstrates that the science literacy of vocational school physics teachers still falls short of expectations (Rahayu et al. 2018). In a similar study, Murti, Aminah, and Harjana (2018) evaluated High School Students' Science Literacy in Karanganyar Regency, Central Java, Indonesia using NOSLiT. The results showed that while most students had attained science literacy, some of them still lack the necessary skills. According to Murti et al., (2018), 86.2% of the students already possessed scientific literacy while 13.8% of the students did not possess scientific literacy. It shows that student literacy in science is better than Wenning's research with an average score of 20.8 from total 35 (59.6%). They further observed that majority of the students have fulfilled frameworks such as science nomenclature, experimental ability and basic observation, scientific postulate, and rules of scientific evidence in such a large number while frameworks such as scientific disposition and major misconception about science were still in small number. Ariyanti et al., (2016) developed a NOSLiT-based exam of scientific literacy for Indonesian Senior High School students across grade levels. The NOSLiT question items were translated from English to Indonesian language. The results of the study showed that students in grade X, grade XI, and grade XII received average NOSLiT test scores of 16.86, 15.78, and 16.40 respectively. Students fell into the moderate literacy category because their science literacy score was fairly low, or they did not earn at least 50% of the overall score (Ariyanti et al., 2016). Garner-O’Neale and Ogunkola (2015) also adapted NOSLiT to undergraduate chemistry students in Barbados and reported that the students scored a mean of 24.4 (68.6%). They concluded that the chemistry students did reasonably well compared to physics high school students and teachers in the United States, as described in Wenning’s (2006) study. Noor, (2022) used the NOSLiT in a study. The purpose was to assess the level of scientific literacy based on the OECD’s (2013) three domain-specific competencies of scientific literacy among secondary school students in Malaysian and English suburban schools. The three OECD competencies were; explain phenomena scientifically, evaluate and design scientific enquiry and interpret data and evidence scientifically. The findings indicated that students from Malaysian suburban schools achieved an overall mean score of 17.73 out of 35, or 51%, while the students from English suburban schools achieved an overall mean of 26.33, or 75%. Thus, scientific literacy of suburban schools in England was higher than in Malaysian suburban schools. Similar to the aforementioned studies, the present study used NOSLiT to gauge the scientific literacy of students in an urban and a rural Senior High Schools in Ghana.

There is no universally accepted definition of a rural area because different countries have different ideas about what "rural" means (Adedeji & Olaniyan, 2011). According to the Ghana Statistical Service (2002), a community with a population of less than 5000 is classified as rural, while a community with a population of 5000 or more is classified as urban. In the context of this study, a rural school is one found in a community with fewer than 5000 people, while an urban school is one found in a community with more than 5000 people. In most cases, these rural communities lack basic social amenities and infrastructure. Kashaa (2012) simply describes rural areas as depressed, with a lack of government development interventions such as potable water, electricity, good roads, and school infrastructure to improve people's lives. Similarly, rural schools in Ghana lack good infrastructure and facilities, as well as low enrolment, less qualified teachers, and fewer textbooks and other teaching and learning materials, whereas urban schools are generally overstaffed with qualified teachers, overenrolled, better funded and monitored, and have better infrastructure and adequate resources to work with (Anamuah-Mensah, 2002; The President's Committee on Review of Education Reforms in Ghana, 2002; Siaw, 2002). It is argued that a lack of these resources discourages teachers from teaching science (Fredua-Kwarteng & Ahia, 2005), thereby affecting students' academic performance. Other studies have found a link between school location and student academic achievement in science. Adepoju (2001) discovered that students in urban schools perform better than their rural counterparts. In Serbia, the results of the national test in mathematics and Serbian language in 2004 revealed that grade three students from urban areas outperformed their peers in rural schools (Baucal et al., 2007). Similarly, in Ghana, urban schools outperform rural schools because they have prestigious names and character, more qualified teachers, and they attract and admit high-performing BECE applicants into the Visual Arts Department. The authors also discovered that the geographical location of the school and educational opportunities have a direct impact on students' academic performance and achievement (Opoku-Asare & Siaw, 2015; Okyerewa, Nortey & Bodjawah, 2013). In contrast to the previous studies, students from rural schools were discovered to have a competitive advantage over their urban counterparts (Alspaugh & Harting,1995). However, some studies have found no statistically significant differences in achievement between rural and urban students (Alspaugh, 1992; Howely & Gunn, 2003, Lee & Mclntire, 2000). Because there is a link between school location and student academic achievement, the author believes that school location will influence students' scientific literacy level.

2. Methodology

This was a case study that employed both quantitative and qualitative approaches to explore the scientific literacy of two Senior High Schools in Ghana. Three separate steps of sampling were carried out to select the participants for this study. The two participating Senior High Schools were selected in the first step using a purposive sampling technique. The study chose one school from an urban setting and one from rural setting. This was purposely done to establish the relationship between geographical location of schools in Ghana and the scientific literacy of students. Both of the selected schools were public Senior High Schools run by the Ghana Education Service (GES). In the second step, 78 students from each school selected (rural and urban) were conveniently sampled, giving the study a total of 156 participants. In the final step, convenient sampling was used to pick 5 students from each school, who were then engaged for focused group discussions.

Focused group discussions and questionnaire were employed to collect the data for this study. The questionnaire used consisted of two sections. Section A is the student’s demographic data whilst section B is the Nature of Science Literacy Test (NOSLiT) developed by Wenning. The NOSLiT is a 35-item multiple-choice test created to evaluate high school students' knowledge of science's fundamental principles. It consists of six frameworks which includes science nomenclature (7 items), experimental ability and basic observation (6 items), rules of scientific evidence (7 items), scientific postulate (8 items), scientific disposition (1 item), and major misconception about science (6 items). The single best response was to be chosen after careful consideration of all the possibilities. Additionally, it was expected of the students to provide autonomous, truthful responses to the questions based on their understanding. Students were given the assurance that the test was solely given for educational research and that the outcome would be kept private and would not form part of their continuous assessment of the term. A total of 156 questionnaires were distributed. For sections A and B of the questionnaire, descriptive analysis was used. The responses from the focus group discussions were categorized and summarized. Section B (NOSLiT) responses were scored; a correct answer is worth 1 and a wrong answer is worth zero. The responses were classified as frequency counts, percentages, and mean scores. A t-test analysis was used to determine the statistical difference between the scientific literacy level of students across school location. A student who had a total grade point average of 18 (51%) out of 35 is scientifically literate. The total scores for each student was interpreted as ‘low’, ‘pass’, ‘high’, ‘very high’ and ‘excellent’. The outcomes from both schools were compared.

3. Results and Discussions

A total of 156 students participated in this study. In all, 66 (42.3 %) of the respondents were male students; 90 (57.7%) were female students. Students age ranged between 17 years and 18 years. The mean NOSLiT scores for students across school locations are shown in Table 1.

Table 1: Mean scores with respect to school location

School location	N	Mean	SD	Percentage
Urban	78	16.19	5.86	46.3
Rural	78	15.03	4.08	43.0

According to the results in Table 1, students in urban schools had a higher mean score of 16.19 out of the 35 NOSLiST test items, whereas students in rural schools had an overall mean score of 15.03. This suggests that students in the urban school had higher levels of scientific literacy than their counterparts in the rural school. In this study, the mean scores for students across school locations were lower than the mean scores achieved by students in the United States of America (Wenning, 2006) and Malaysia and the United Kingdom (Noor, 2022). Wenning's students received a mean score of 20.8, while Noor's students received 17.73 and 26.33 in Malaysia and the United Kingdom, respectively.

Table 2: Students score of the NOSLiT test

Students score (%)	Score interpretation	Urban		Rural	
		Frequency	%	Frequency	%
≤49	Low	45	50.0	58	64.4
50-60	Pass	13	14.4	14	15.6
61-70	High	16	17.8	5	5.6
71-80	Very high	2	2.2	1	1.1
≥81	Excellent	2	2.2	0	0.0

According to Table 2, 33 (42.3%) of urban school students have achieved scientific literacy, while the majority of them 45 (57.7%) have a low level of scientific literacy. Similarly, 20 (25.6%) of the rural school students have achieved scientific literacy, while 58 (74.4%) have a low level of scientific literacy. Students in the urban school demonstrated higher levels of scientific literacy (16 (17.8%) than students in the rural school (5 (5.65%). Furthermore, two (2.2%) students in the urban school demonstrated excellent scientific literacy, whereas none in the rural school demonstrated excellent scientific literacy. The level of students' scientific literacy was examined using a T-test analysis to see if there were any statistically significant differences between schools.

Table 3: T-test analysis of scientific literacy scores of rural and urban schools

Variable	Mean	SD	T	p
Urban	16.19	5.86	1.4258	0.07
Rural	15.03	4.08		

The results of a t-test analysis to determine any differences in statistical significance between the mean responses of students' levels of scientific literacy across school location are displayed in Table 3. Students in rural school ($M = 15.03$, $SD = 4.08$) and students in urban school ($M = 16.19$, $SD = 5.86$) did not differ significantly in their levels of scientific literacy, according to $t(1.977) = 1.426$, $p = 0.07 > 0.05$.

The scientific literacy level of the students in this study was presented and discussed using the six frameworks used by (Ariyanti et al., 2016; Murti et al., 2018) in their studies: ability to understand science nomenclature, experimental ability and basic observation, rules of scientific evidence, scientific postulate, scientific disposition, and major misconception about science. Figure 1 compares the scientific literacy of urban and rural students across the six frameworks.

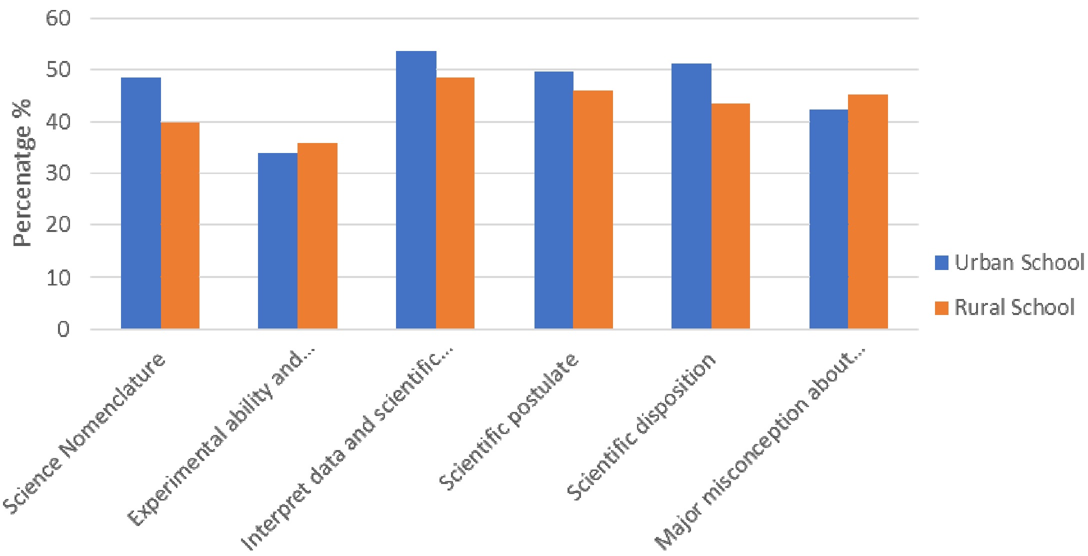

Figure 1: The comparison of scientific literacy level of students in urban and rural schools across the six frameworks

Framework 1 (science nomenclature) necessitates the ability to recall the meaning of scientific terms, how such terms were derived to explain scientific occurrence experiences, and when to use them. Six NOSLiT questions assessed students' scientific literacy in terms of scientific nomenclature. Theory, model, law, hypothesis, and deductions are the scientific terms being tested in Framework 1. These are scientific terms that students must understand and use correctly in order to achieve scientific literacy. Science literacy refers to an individual's ability to comprehend scientific laws, theories, phenomena, and things (Dragoș & Mih, 2015). The average percentage score for framework 1 (science nomenclature) revealed that urban students (48.4%) outperformed rural students (39.7%). For framework 1, students in Murti et al. (2018)'s study scored higher than rural school students and lower than urban school students in this study. Again, students in grades 10, 11, and 12 of Senior High Schools in Indonesia outperformed both schools in Ghana in this framework (Ariyanti et al., 2016). Similarly, in Henukh et al (2021) study, grade 8 students outperformed Ghanaian students across all school locations. According to the findings, the majority of Ghanaian students lacked scientific literacy on this framework. This could be because students did not understand the meaning of the scientific terms or the context in which they were used. The translation of NOSLiT question items from English to Indonesian language may have resulted in higher scientific literacy among Indonesian students in Ariyanti et al., (2016) and Murti et al., (2018) studies. Giving Indonesian students a better understanding of scientific terminology. According to studies, learning a second language is considered difficult when students have difficulty deducing the meaning of Mathematics and Science concept words (Tan & Tan, 2008; Ferreira, 2011; Quansah et. al., 2019). During the focused group discussion, the students confirm this finding. *"There are big big terms in science that we don't use in most of the other subjects we study, but you have to understand them".* Students' inability to understand these scientific terms in order to respond appropriately to the items contributed to their poor performance in Framework 1, and thus their level of scientific literacy.

Framework 2 (experimental ability and basic observation). These are the experimental and process skills that students must learn in order to be able to use acceptable scientific processes to identify and solve problems in their environment. Wenning (2006) believes that students can gain a comprehensive understanding of science if they have experience with empirical methods. The process of learning science focuses on the individual's process skills. According to Mandor (2002), Science Process skills have the added benefit of contributing to students' abilities to explore their environment, answer questions, and solve difficult problems. Students must also use critical thinking and reasoning to complete the framework. Scientific literacy requires the acquisition of experimental and process skills. Scientific literacy entails understanding the nature of science as well as analytical skills such as designing experiments, collecting and analysing data, and drawing valid conclusions from evidence (Ogunkola, 2013). These abilities enable the scientifically literate person to think critically and use scientific processes to identify and solve problems in their homes and communities. According to the findings of this framework, the questions appear difficult for the students, with less than 35.5% of students from both schools correctly answering the items. Similar results were found in an Ariyanti et al., (2016) study in Indonesia, where only 40% of senior high school students correctly answered these questions. The inability of students to answer these questions could be due to how science concepts are presented to them. The low scientific literacy demonstrated by students on this framework 2 (experimental ability and basic observation) confirms the claim of Ngman-Wara, (2011) and Osei, (2004), who contend that instructional approaches in Ghanaian Science classrooms are mostly teacher-centered, despite the curriculum emphasizing inquiry processes in Science teaching (MoESS, 2010). This assertion is confirmed during the focus group discussion.

A student opined that: *''Our teachers say the topics in the integrated science syllabus is so much that we have to move fast to finish the syllabus. Anytime they come to class they explain the topics to us without letting us go to the laboratory''.*

One of them also said: *"the questions from WAEC on Integrated Science are mostly define, explain, what is and others, all we have to do is to memorize all that we have been taught for us to pass our examination''.*

Another student said: *"there is no hands-on practical test in the final examination of integrated science subject, all we have to do is to learn the steps in practical activities and we are good to go".*

The use of a teacher-centered approach to teaching promotes rote memorization of knowledge rather than developing students' thinking abilities. To help students understand scientific concepts, science teaching and learning should be student-centered, with opportunities for students to develop their experimental and process skills, as well as their critical thinking abilities. As a result, the use of inquiry processes as an instructional strategy advocated in the 2010 Integrated Science Teaching Syllabus for SHS may be ineffective in Ghanaian science classrooms.

Data and scientific evidence must be interpreted (framework 3). A scientist is expected to interpret data and draw an accurate and justifiable conclusion from a dataset. Scientific literacy is defined as the ability to evaluate the quality of information and arguments presented by scientists and in the media (Dragoș & Mih, 2015). The overall score on Framework 3 for students in the urban school was 53.8%, while students in the rural school scored 48.5%. Students in urban schools outperformed their counterparts in rural schools because they have access to more information and learning resources. In general, urban schools have more qualified teachers, better infrastructure, and adequate resources (Anamuah-Mensah, 2002; The President's Committee on Review of Education Reforms in Ghana, 2002; Siaw, 2009). This was confirmed when a student in the urban schools stated:

"we have acces to other sources of information (library, internet, social media) aside what we get from our teachers". According to Durant and Thomas (1989), better informed people may be able to function more successfully in society. Individuals who have access to adequate information can interpret data from various perspectives. As a result, students in urban schools outperformed their counterparts in rural schools.

The Framework 4 (scientific postulate) are the assumptions that underpin scientific work and thought. Based on one's understanding of the basic scientific concept being applied, one can understand occurrences and information. According to Brewer (2008), you can only assess whether the information being offered to you is true and fair if you have a basic understanding of science. According to Dragoș and Mih (2015), scientific literacy is the ability to use evidence and data to evaluate the quality of information and arguments presented by scientists and in the media. Students in the urban school outperformed their counterparts in the rural school. Students in urban schools scored 49.8% on this framework, while students in rural schools scored 46.1%. Murti et al. (2018) discovered similar results with Indonesian students. The inability of most students across school districts to achieve a pass mark in this framework indicates that they have not grasped the understanding that scientific ideas are based on assumptions that are acceptable to the scientific community. Students from both schools agreed that there is a lot of information on the internet and that they sometimes get confused about which one is correct.

Framework 5 (scientific disposition), this framework assesses an individual's proclivity to act in a specific manner when conducting scientific research. This framework is represented by question 22, which asks how other scientists will react to a highly respected scientist's prediction of future events. More than half of students (51.3%) in urban schools and less than half (43.6%) in rural schools correctly answered this question. This finding contradicts (Ariyanti et al., 2016) but is consistent with Murti et al., (2018) study in Indonesia. The lack of scientific literacy demonstrated by students in both schools in this study suggests that the majority of students do not understand basic scientific facts, theories, and explanations of scientific concepts around them. In this framework, demonstrating low scientific literacy may limit an individual's ability to explain scientific occurrences in their surroundings using scientific facts and theories. Again, demonstrating low scientific literacy in this framework may imply that students are unable to identify and solve problems in their communities. As a result, the nation's goal of the individual possessing some desirable characteristics of a scientist on how to deal objectively with phenomena and other practical issues; avoiding reliance on superstition for explaining the nature of things (MoESS, 2007) may appear to be a mirage.

Framework 6 (major misconception about science). Misconceptions in science education are widely held beliefs about science that are not supported by actual scientific knowledge (Ajayi, 2017). Students (45.3%) in the rural school outperformed students (42.3%) in the urban school. However, the majority of students from both schools demonstrated low literacy levels due to their inability to distinguish between scientific fact and misconception. This finding is consistent with the findings of Murti et al (2018) study in Indonesia. The students' inability to interpret the statements correctly may be due to a lack of critical thinking skills. If students are unable to distinguish between misconceptions and scientific facts, their ability to achieve higher levels of scientific literacy may suffer. Misconceptions, according to Patil, Chavan, and Khandagale (2019), are barriers to good science learning.

4. Conclusion

This study looked into the scientific literacy of students in urban and rural Senior High Schools in Ghana. The study also sought to determine whether there is significant difference in students' scientific literacy between the two schools. Based on the findings, it is possible to conclude that students from various school locations demonstrated low scientific literacy levels in almost all of the NOSLiT instrument's six frameworks. Students in the rural school, on the other hand, demonstrated lower levels of scientific literacy in all six frameworks studied. There was, however, no statistically significant difference in student performance across school locations. This suggests that science education, particularly in rural schools, needs to be improved. NOSLiT, according to Wenning (2006), is best used as a research tool for identifying gaps in student understanding, improving instructional practice, and determining program effectiveness. It is hoped that the findings of this study will persuade science teachers in Senior High Schools to use the inquiry processes of science teaching (MoESS, 2010) as prescribed in the science syllabus if Ghana is to achieve quality science education.

Acknowledgements
I am very grateful to Dr. Mohd Syafiq Aiman Mat Noor Department of Education, School of Education, College of Business, Arts and Social Sciences, Brunel University London, United Kingdom for assisting me with the NOSLiT instrument. I am also grateful to the Senior High School students who participated in this study. My appreciation also goes to Mr Charles Essiam and Mr Emmanuel Osei who took time to read through the manuscript and made suggestions for the improvement of the work.

References

Adedeji, S. O., & Olaniyan, O. (2011). *Improving the conditions of teachers and teaching in rural schools across African countries*. UNESCO-IICBA.
Adepoju, T. (2001). Location factors as correlates of private and academic performance of secondary schools in Oyo State. In *A proposal presented at the higher students. Joint staff seminar Department of Teacher Education, University of Ibadan, Ibadan*.
Alspaugh, J. W. (1992). Socioeconomic measures and achievement: Urban vs. rural. *Rural Educator*, *13*(3), 2-7.
Alspaugh, J. W., & Harting, R. D. (1995). Transition effects of school grade-level organization on student achievement. *Journal of Research & Development in Education*. *28*(3), 145-149.
Anamuah-Mensah, J. (1994). The race against underdevelopment: Mirage or reality? *International Journal of Science Education* 14, 32.
Anamuah-Mensah, J. (1998). *Science Education as a tool for national development: The missing Framework*. A paper prepared for presentation at Eastern Washington University, USA
Anamuah-Mensah, J. (2002). Meeting the challenges of education in the twenty first century. President committee on the review of new educational reform.
Ajayi, V. O. (2017). Effect of hands-on activities on senior secondary chemistry students achievement and retention in stoichiometry in Zone C of Benue State. *Available at SSRN 2992803*.
Ariyanti, A. I. P., Ramli, M., & Prayitno, B. A. (2016, January). Preliminary study on developing science literacy test for high school students in Indonesia. In *Proceeding of International Conference on Teacher Training and Education* (Vol. 1, No. 1).
Baucal, A., Pavlovi´c-Babi´c, D., Plut, D., & Gvozden, U. (2007). National educational testing Achievements of Grade III Elementary School Students - Report for the Ministry of Education and Sports [Grade 3 national assessment: Report for the Ministry of Education and Sport of the Republic of Serbia]. Institute for Evaluation of the Quality of Education and Training.
Brewer, C. (2008). Scientific Literacy in the Classroom. *American Institute of Biological Sciences*.
Dragoș, V., & Mih, V. (2015). Scientific literacy in school. *Procedia-Social and Behavioural Sciences*, *209*, 167-172.
Durant, J. R., Evans, G. A., & Thomas, G. P. (1989). The public understanding of science. *Nature*, *340* (6228), 11-14.
Ferreira, J. G. (2011). Teaching Life Sciences to English second language learners: What do teachers do?. *South African Journal of Education*, *31*(1).
Fredua-Kwarteng, Y., & Ahia, F. (2005). Ghana flunks at math and science: Analysis (2). Feature article. *Ghana News*, *23*.
Garner-O'Neale, L., & Ogunkola, B. (2015). Effects of interest in science, study habits, sex and level of study on

the nature of science literacy level of undergraduate chemistry students of the University of the West Indies, Barbados. *Journal of Educational and Social Research*, *5*(2), 267-267.

Ghana Statistical Service. (2002). *2000 Population and housing census: Summary report of final results*. Ghana Statistical Service.

Henukh, A., Simbolon, M., Astra, I. M., & Rosdianto, H. (2021). Analysis of Students' Science Literacy Ability on Heat Concept. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(2), 178-184.

Howley, C. B., & Gunn, E. (2003). Research about mathematics achievement in the rural circumstance. *Journal of Research in Rural Education*, *18*(2), 86-95.

Jenkins, E. W. (1994). Public understanding of science and science education for action. *Journal of curriculum studies*, *26*(6), 601-611.

Kashaa, N. (2012). *Teachers in deprived communities: Is it a punishment?* Featured article on Wednesday 14 November. Retrieved from www.ghanaweb.com/GhanaHomePage/features/ Teachers-In-Deprived-Communities-Is-It-A-Punishment?

Laugksch, R. C. (2000). Scientific literacy: A conceptual overview. *Science education*, *84*(1), 71-94.

Lee, J., & Mcintire, W. G. (2000). Interstate variation in the mathematics achievement of rural and non-rural students. *Journal of Research in rural education*, *16*(3), 168-181.

Lewenstein, B. V. (2003). Models of public communication of science and technology.

Mandor, A. K. (2002). Effects of constructivist based instructional model on acquisition of science process skills among junior secondary students. *Unpublished M. Ed Thesis*.

McPhearson, P. T., Gill, S. P., Pollack, R., & Sable, J. E. (2008). Increasing scientific literacy in undergraduate education: A case study from "frontiers of science" at Columbia University. *A vision of transdisciplinarity: Laying foundations for a world knowledge dialogue*, 148-161.

Ministry of Education Science and Sports (MoESS). (2010). *Teaching Syllabus for Integrated science* (*Senior High School 1-3*). Ghana: Curriculum Research Development Division.

Ministry of Education Science and Sports (MoESS). (2007). *Teaching Syllabus for Integrated science* (*Junior High School 1-3*). Ghana: Curriculum Research Development Division.

Murti, P. R., & Aminah, N. S. (2018, September). The Analysis of High School Students' Science Literacy Based on Nature of Science Literacy Test (NOSLiT). In *Journal of Physics: Conference Series* (Vol. 1097, No. 1, p. 012003). IOP Publishing.

Ngman-Wara, E. I. D. (2011). Ghanaian junior high school teachers attitudes, knowledge of contextualised science instruction. *A thesis in the University of Education Winneba*.

Noor, M. S. A. M. (2021). Assessing secondary students' scientific literacy: A comparative study of suburban schools in England and Malaysia. *Science Education International*, *32*(4), 343-352.

Nuangchalerm, P. (2010). Engaging Students to Perceive Nature of Science through Socioscientific Issues-Based Instruction. *Online Submission*, *13*(1), 34-37.

Ogunkola, B. J. (2013). Scientific literacy: Conceptual overview, importance and strategies for improvement. *Journal of Educational and Social Research*, *3*(1), 265-274.

Organization for Economic Cooperation and Development (OECD). (2015). *PISA 2015 Draft science framework.* (Paris, OECD) pp 1–54

Okyerewa, A., Nortey, S. S., & Bodjawah, E. K. (2013). Teaching and Learning of Visual Arts in Senior High Schools in Rural and Urban Settings in Ghana. *International Journal of Technology and Management Research*, *1*(2), 67-75.

Opoku-Asare, N. A. A., & Siaw, A. O. (2015). Rural–urban disparity in students' academic performance in visual arts education: evidence from six senior high schools in Kumasi, Ghana. *SAGE Open*, *5*(4), 2158244015612523.

Osei, G. M. (2004). The 1987 Junior secondary-school Reform in Ghana: Vocational or Pre-vocational in nature?. *International Review of Education*, *50*(5), 425-446.

Patil, S. J., Chavan, R. L., & Khandagale, V. S. (2019). Identification of misconceptions in science: Tools, techniques & skills for teachers. *Aarhat Multidisciplinary International Education Research Journal (AMIERJ)*, *8*(2), 466-472.

Quansah, R. E., Sakyi-Hagan, N. A., & Essiam, C. (2019). Challenges Affecting the Teaching and Learning of Integrated Science in Rural Junior High Schools in Ghana. *Science Education International*, *30*(4), 329-333.

Rahayu, P. P., & Masykuri, M. (2018, April). Analysis on the science literacy ability of vocational school physics teacher using NOSLiT indicators. In *Journal of Physics: Conference Series* (Vol. 1006, No. 1, p. 012030). IOP Publishing.

Siaw, A. O. (2009). A comparative study of teaching and learning processes of the visual arts in selected senior high schools in urban and rural settings in Ashanti Region, Ghana. *M. Ed. Thesis submitted to Kwame Nkrumah University of Science and Technology, Kumasi, Ghana*.

Tan, A. L., & Tan, S. C. (2008). Authority and Transmission versus Knowledge Building: Dilemmas in Learning

Science. In *Science education at the nexus of theory and practice* (pp. 239-251). Brill.
The President's Committee on Review of Education Reforms in Ghana. (2002). *Meeting the challenges of education in the 21st century*. Accra, Ghana: Adwinsa Publications.
Towse, P. J., Anamuah-Mensah, J., Mushi, P. S. D., & Kent, D. W. (2005). Bridging the gap: Linking school and the world of work (pp. 21). *An education research study funded by the Department for International Development. SACOST, University of Education, Winneba, Ghana*.
Walberg, H. J. (1983). Scientific literacy and economic productivity in international perspective. *Daedalus*, 1-28.
Wenning, C. J. (2006). Assessing nature-of-science literacy as one component of scientific literacy. *Journal of Physics Teacher Education Online*, *3*(4), 3-14.