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Perspectives of secondary school teachers on nature of science in Lagos

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ABSTRACT

This research explored the perspectives of teachers on the characteristics of science. The research was a descriptive study using surveys. Science teachers from Lagos state made up the sample for the study. The study answered three research questions and tested two hypotheses. The instrument used was the Science Teachers Nature of Science Assessment Questionnaire (STNOSAQ, r = 0.78). The analysis was carried out with the use of descriptive and inferential statistics. Findings from the study showed that teachers possess inadequate perception of scientific knowledge, inquiry, and enterprise. The result also revealed no significant disparity in the male and female teachers' perception of nature of science. However, teachers' qualifications significantly influence a difference in teachers' perception of the characteristics of science enterprise. Training of teachers teaching science is recommended for improvement of individual's perspectives about the nature of science. This could be achieved through professional development programs.

Keywords: Nature of science, Perception, Science, Secondary school, Teachers

1. INTRODUCTION

Science deals with systematic observation and experimentation of structure and behaviour of the physical, social and natural world. It involves understanding of the physical world through observations, measurements and experiments. Cassimally (2011) refers to science as the systematic understanding of behaviour of the natural world while Bhayat (2018) describes science as systematic facts, observation and experiments. Science deals with knowledge about the natural world. Therefore, science involves observations and explanations of the universe in a systematic and logical approach. It involves systematic and organized inquiry into the natural world. The discoveries in sciences are systematically organized into body of knowledge that is referred to as scientific knowledge. Scientific knowledge is generalised body of laws and theories used to explain phenomenon and behaviours about the universe that are acquired through scientific methods (Da Silva 2022).

To explicitly teach science, teachers need to constantly incorporate how scientific knowledge is created and validated over time. This provides students with an understanding of science concepts. Studies have shown that the teaching of science increases leaners' understanding of the subject matter (Vhurumuku 2011), develops scientific literacy in individuals (Pavez et al., 2016), and enhances students' understanding of science and the ability to make socio-scientific decisions (Saif, 2016) in life. Nature of science is characterized with how scientific knowledge is developed. Therefore, integrating characteristics of science in classroom during teaching is important. In view of this, it is important for teachers to possess a good comprehension of nature of science and develop appropriate method of incorporating it while teaching science subjects. For appropriate teaching of science, teachers need adequate knowledge for acquisition of qualities of science so as to choose appropriate pedagogy to relate nature of science with science content and concepts. Studies, Allchin (2011), and Sumranwanich and Yuenyong (2014) indicate that science teachers need a good perception of characteristics of science for the purpose of teaching science.

However, it has been noted in research (Aslan & Tasar 2013) that it is difficult for teachers to teach and implement nature of science in instruction. Damirel, Sungur and Cakiroglu (2023) noted that science teachers possess inadequate knowledge of nature of science. This study found that the teachers use scientific practices and scientific methods interchangeably. This may influence teachers' perspectives about, and ability to use nature of science in classroom instruction. In view of the above, the researcher investigated the perspectives of science teachers in Lagos state on nature of science, i.e scientific knowledge, scientific inquiry and scientific enterprise.

1.1. Statement of the problem

The teaching and learning of science are important to the development of a country. Over the years, science educators have continuously emphasized enhancing students' understanding and learning of science. Several pedagogical approaches, curricular reviews, have been developed toward improvement in learning science. One of the major ways to improve students' performance in science may be to help students to develop informed conceptions of creation and testing of scientific knowledge through incorporation of nature of science in classroom. An understanding of creation and development of scientific knowledge over time is germane in enhancing students' knowledge and learning in science. To achieve an excellent learning of students in science, teachers must have good knowledge and perception of features of scientific knowledge, its creation and validation which is characteristics of science for adequate teaching and appropriate learning of science. Studies have sought relevance of, and teachers' understanding of nature of science. In order to use this appropriately in classroom, teachers' perspectives of nature of science are also important. Therefore, the research examined the perceptions of teachers about characteristics of science – scientific knowledge, scientific inquiry and scientific enterprise.

Objectives of the study

The study specifically found out:

1. science teachers' perception of nature of science.
2. influence of teachers' qualifications on perception of nature of science.
3. influence of teachers' gender on perception of nature of science.

Research questions

1. What are teachers' perception of scientific knowledge?
2. What are teachers' perception of scientific inquiry?
3. What are teachers' perception of scientific enterprise?

Hypotheses

1. There is significant difference between science teachers' perception of features of scientific: knowledge, inquiry and enterprise.
2. There is significant gender difference between science teachers' perception of features of science.
3. There is significant qualification difference in science teachers' perception of features of science.

2. LITERATURE REVIEW

Science describes the process of producing knowledge. The process involves careful observation of phenomena and production or deduction of theories from the observations. Science is important for the development of a country hence acquisition of its knowledge is paramount for an individual. According to Cullinane and Erduwan (2022), in acquiring scientific knowledge for adequate and appropriate scientific literacy, understanding the creation and validation of research-based knowledge as feature of science is a requisite. Galili (2019) described nature of science as a meta perspective of science. This process involves behaviour, attitude, reports, experiences and practical aspects in science. Nature of science consists of different aspects such as epistemology, scientific process and scientific laws and theories. Epistemology is science knowledge while scientific process is the methods of generating knowledge and how they are applied. Quality of science explains characteristics of scientific knowledge and the different underpinning scientific activities. It is described as a multifaceted concept that includes knowledge of science and evidence and reasoning as actions of science. According to Bell, Gullinance and Erduwan (2022), and Lirea-Garden et al. (2023), science educators described nature of science as a key set of ideas that includes tentativeness, observation and inference, empirical evidence, scientific laws and theories, scientific methods, creativity, objectivity and subjectivity. The nature of science is important in the understanding of science concepts; therefore, it is germane in the teaching process. Erduran et al. (2023) and Bulingo, Yadau and Mugisha (2024) acknowledged the importance of nature of science in science instruction and students' performance.

In teaching and learning process, according to Arthur and Obeng (2023), teachers are important, the way teachers carry out the educational process has an impact on learning outcomes of students. In the same view, science teachers are important in the teaching and learning of science. The fundamental of teaching and learning of science lies in knowledge of characteristics of science. Characteristics of science is a key element that enhances students' knowledge of science and aids good learning of scientific concepts. Therefore, it is appropriate for science teachers to integrate characteristics of science which is nature of science in classroom for adequate learning by students. However, Kunene (2014) reported that studies on nature of science and teaching have revealed relationships between science teachers' knowledge and what they teach in classroom. Ndeke et al. (2015) and Bell, Mulvey and Maeng (2021), also reported positive influence of teachers 'perception about nature of science on classroom practices. This implies that teachers view about the process of generating and validating scientific knowledge influences how teaching takes place in classroom. Meanwhile, studies showed that

most teachers around the world have limited understanding of NOS (Capps & Crowford, 2013), and when science teachers claim to possess the knowledge of characteristics of science, it is usually a stressful experience in the process of teaching (McComas et al., 2020; Wahbeh & Abd-EL-Khalick, 2014). Sarkar and Gomes (2010) also found that Bangladesh teachers have naïve views about NOS while Aslam and Tasar (2013) reported that few Turkish science teachers hold informed views about and teach the NOS. In Nigeria, there are few studies on science teachers' teaching and perception of nature of science. These few available studies addressed different subjects under science and not variables that involve all the science teachers.

3. RESEARCH METHOD

There are six Education Districts in Lagos State. Each Education Districts in Lagos state were used for this study. One secondary school with six years program (for instance, three-year junior secondary school and three-year Senior Secondary School) was selected randomly from each of the Education Districts. All science teachers (teachers teaching Basic Science, Biology, Chemistry and Physics) were participants in the study. This made up 53 science teachers that participated in the study. The instrument used to collect data for the study was Science Teachers' Nature of Science Assessment Questionnaire (STNOSAQ), adapted from Saif (Saif, 2016). The reliability of STNOSAQ was determined with the use of Cronbach Alpha and the reliability index was 0.78. The instrument was made up of two Sections. The first section was made up of information about the participants while the second section composed of statements or items on teachers' perspectives about scientific knowledge, inquiry and enterprise on a three-point Likert scale (Agree, Undecided, Disagree).

4. DATA ANALYSIS

The results are presented according to research questions and hypotheses.

Research question One: What is teachers' perception of scientific knowledge?

Table1: Science teachers' responses on perception of scientific knowledge

Items	Agree (%)	Uncertain (%)	Disagree (%)
1. Hypotheses serve as the foundation for building a theory	85.8	9.4	3.8
2. Scientific theories are more subjected to change than laws	66.0	9.4	24.5
3. Scientific theories can become law after proven tests	83.0	9.4	7.5
4. Scientific knowledge is certain	22.6	28.3	49.1
5. Accumulation of evidence makes scientific knowledge to be more established	84.9	13.2	1.9
6. A scientific model is a conceptual representation of a phenomenon or process	67.9	20.8	11.3
7. Creativity and imagination used in acquisition of scientific knowledge.	47.2	15.1	37.7
8. Scientists are very receptive	73.6	22.6	3.8

Table 1 shows that most of the science teachers (85.8%) agreed that hypotheses serve as the foundation for building a theory, scientific theories are more subjected to change than laws (66.0%), scientific theories can become laws after proven tests (83.0%). At the same time, 9.4% participants were undecided with the issues while 3.8%, 24.5% and 7.5% disagreed with the statements respectively. Table 1 also shows that 22.6% of the participants perceived that scientific knowledge are certain, while 28.3% were undecided about the statement and 49.1% disagreed that scientific knowledge is certain. 84.9% participants agreed that accumulation of evidence makes scientific knowledge to be more established, 13.2% of the participants were undecided that scientific knowledge is more established with accumulation of evidences while 1.9% participants disagreed with the statement. 67.9% participants agreed that a scientific model is a conceptual representation of a phenomenon or process, 20.8% were undecided, while 11.3% participants disagreed with the statement. Participants' responses showed that 47.2% agreed that creativity and imagination is used in acquisition of scientific knowledge; 15.1% participants were undecided while 37.7% participants disagreed. Most of the participating teachers (73.6%) agreed that scientists are very receptive, 22.6% couldn't decide while 3.8% disagreed with the statement.

Research Question Two: What is teachers' perception of scientific inquiry?

Table 2: Science teachers' responses on perception of scientific inquiry

S/N	Items	Agree (%)	Undecided (%)	Disagree (%)
1.	Scientific method is a set of general principles with sequence of steps	84.9	9.4	**5.7**
2.	Scientific method is a process for experimentation used to acquire knowledge	37.7	45.3	**37.7**
3.	Scientific knowledge only comes from experiments	75.5	9.4	15.1

Table 2 reveals that most of the science teachers (84.9%) agreed that scientific method is a set of general principles with sequence of steps, 9.4% teachers were undecided while 5.7% disagreed to the statement. 17.0% participants agreed that scientific method is a process for experimentation used to acquire knowledge, while 45.3% were undecided and 37.7% disagreed. 75.5% of participants agreed that scientific knowledge only comes from experiment, 9.4% of the participants were undecided while 15.1 disagreed.

Research Question Three: What is teachers' perception of scientific enterprise?

Table 3: Science teachers' responses on perception of scientific enterprise

S/N	Items	Agree (%)	Undecided (%)	Disagree (%)
1.	Science and technology are intertwined	79.2	9.4	11.3
2.	Society, politics and culture influence the development of scientific knowledge	49.1	1.15	8.3
3.	Scientific enterprise means leverage and commercialization of scientific research	20.8	20.7	58.5

Table 3 shows that 79.2% participants agreed that science and technology are intertwined, 9.4% of participants were undecided on the statement while 11.3% participants disagreed. 49.1% of participants agreed that society, politics and culture influence the development of scientific knowledge, 15.1% were undecided on the issue while 35.8% of participants disagreed. Also, 20.8% of participants agreed that scientific enterprise means leverage and commercialization of scientific research while 20.7% participants were undecided and 58.5% disagreed about the statement.

Hypotheses

Hypothesis one: There is significant difference between science teachers' perception of features of scientific: knowledge, inquiry and enterprise.

Table 4: One Sample T-test of difference in science teachers' perceptions of of scientific knowledge, inquiry and enterprise

	N	Mean (*X*)	Std.Dev	t-obs	df	p-value
Scientific Knowledge	53	2.49	.23	80.23	52	.00
Scientific Inquiry	53	2.40	.42	41.65	52	.00
Scientific Enterprise	53	2.06	.48	30.96	52	.00

Table 4 above shows p-values less than 0.05 ($p \leq 0.05$) for scientific knowledge, inquiry and enterprise. This is an indication that significant difference exists between science teachers' conceptions of scientific knowledge, inquiry and enterprise. Therefore, the hypothesis is accepted.

Hypothesis Two: There is significant gender difference between science teachers' conception of features of science.

Table 5: One Way Analysis of Variance (ANOVA) of gender difference between participants' perception of nature of science

	Sum of Square	Df	Mean Square	F	Sig
Characteristics of Scientific Knowledge					
Between Groups	.06	1	.06	1.12	.30
Within Groups	2.59	51	.05		
Total	2.65	52			
Characteristics of Scientific Inquiry					
Between Groups	.01	1	.01	.06	.81
Within Groups	9.11	51	.18		
Total	9.12	52			
Characteristics of Scientific Enterprise					
Between Groups	.11	1	.11	.46	.50
Within Groups	12.06	51	.24		
Total	12.17	52			

Table 5 shows no statistically significant gender difference between science teachers' conception of features of science. This is because the p-values are greater than 0.05 respectively, (i.e F (1,51) =1.12, p=0.30; F(1,51) = 0.56, p=0.81; F(1,51) =.46, p=.50). As a result, the alternative hypothesis which states that there is significant gender difference between science teachers' perception of nature of science.is therefore rejected.

Hypothesis Three: There is significant qualification difference in science teachers' perception of nature of science.

Table 6: One Way Analysis of Variance (ANOVA) of difference in participants' qualifications and perception of nature of science

	Sum of Square	Df	Mean Square	F	Sig
Characteristics of Scientific Knowledge					
Between Groups	.017	2	.01	.16	.85
Within Groups	2.63	50	.05		
Total	2.65	52			
Characteristics of Scientific Inquiry					
Between Groups	.32	2	.16	.91	.41
Within Groups	8.81	50	.18		
Total	9.12	52			
Characteristics of Scientific Enterprise					
Between Groups	1.60	2	.80	3.78	.03
Within Groups	10.57	50	.21		
Total	12.17	52			

Table 6 shows the statistical analysis of participants' qualification and conceptions of different aspects of nature of science. The table shows no significant qualification difference in science teachers' conception of characteristics of scientific knowledge (i.e F (2,52) = .16, p= .85) and conceptions of characteristics of scientific inquiry (F (2,52) = .91, p= .41). This is because the p-values are greater than 0.05 respectively. But statistical difference exists between science teachers' qualifications and conceptions of characteristics of scientific enterprise (F (2,52) = 3.78, p= .030).

5. FINDINGS AND DISCUSSION

The findings of the study show that possess naïve view about scientific knowledge, scientific inquiry and scientific enterprise. This shows that science teachers generally possess inadequate perception of nature of science. The implication is that most teachers lack adequate views about the nature of science that is required in teaching science, though lower percentage of teachers showed some perceived knowledge of characteristics of science. This finding agreed with the findings of Linneman et al. (2013) and Gwebu (2015) that characteristics of science is naively understood and perceived by teachers. Govender and Zulu (2017) also concluded that general insufficient knowledge of nature of science among teachers. The insufficient knowledge may be the reason for inadequate perception. The inadequate perception of nature of science by teachers may be due to lack of training and exposure to nature of science during teacher training. Lederman and Lederman (2019) acknowledged that learning of nature of science was not taught as part of science education courses.

The findings of the study also revealed that there is no difference in male and female teachers perception of nature of science. This is against the findings of Saif (2016) and Choudhary, Noor and Javed (2020), that there is disparity in science teachers' gender inadequate perception of nature of scientific knowledge and inquiry with female teachers possessing more inadequacy. This may be due lack of teacher preparation in NOS for both male and female teachers. The result of this study also revealed that teachers' qualifications influence one's perception of nature of science. This is against the submission of Akerson, et al. (2011), with the claim that there is internationally inadequate perception of nature of science amidst teachers regardless of their qualifications.

6. CONTRIBUTION TO KNOWLEDGE

The study exposed science teachers' awareness of the nature of science. It also showed the teachers' existed perception of the nature of science. The naive and uninformed perception of science teachers found out from the study has revealed an implication of low utilization of NOS in classroom. Therefore, the study has contributed to science education by exposing the need for consistent positive perception of nature of science among science teachers for adequate integration in classroom and appropriate learning of science at secondary school. It is also evident that both the male and female teachers are expected to have positive perception of nature of science despite the level of education.

7. IMPLICATION OF THE STUDY

It implies that the nature of science should be part of instruction in science classroom. Therefore, every science teacher should be aware of the nature of science. Inspite of science teachers' gender and qualification, teachers must have good perceptions of the nature of science, understand the different aspects to assist in their incorporation in teaching science.

8. CONCLUSION

From the results of this research, it could be inferred that science teachers in Lagos State, Nigeria generally possesses

inadequate perception of nature of science. The teachers possess uninform perception of scientific knowledge, scientific inquiry and scientific enterprise. They exhibited confusions in regards to characteristics of, and perception of science knowledge, scientific inquiry.

It can also be concluded that the lack of adequate perception nature of science occurs in both the male and female teachers. However, science teachers' perception of nature of science was influenced by teachers' qualifications. This low perceptions of characteristics of science among teachers may influence their modes of instructions and teaching in classrooms, and indirectly influence students' learning.

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