AWARENESS OF SCIENCE TEACHERS IN SCIENCE AND TECHNICAL SCHOOLS ABOUT NANOSCIENCE AND NANOTECHNOLOGY IN F.C.T ABUJA

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Abstract
The growing and rapid advancement in Nanoscience and Nanotechnology have led to the integration of Nanoscience and Nanotechnology courses in colleges or secondary schools, institutes and university curricula all over the world. However, in Nigeria it was only recently introduced in into secondary schools science curriculum. This study seeks to explore the awareness of science teachers in science and technical schools in Abuja about Nanoscience and Nanotechnology (NSNT). A survey research design was adopted for the study. Two research questions and two hypotheses were formulated to guide the study. The population consisted of 224 science teachers (136 Males and 88 Females) from five science and technical schools in Abuja. Simple percentage and frequency counts were used to analysis data questions while Analysis of variance (ANOVA) was used to test the hypothesis. The findings from this study revealed that, science teachers in science and technical schools are not aware of Nanoscience and Nanotechnology (NSNT). The study recommended that all stakeholders in the education sector should organize programs to train science teachers in secondary schools and science and technical colleges on NSNT and how to teach NSNT and its fundamental ideas in the classroom.

Keywords: Awareness, Science Teachers', Nanoscience, Nanotechnology.

Introduction

Nanoscience and Nanotechnology is one of the fastest and latest growing disciplines in the field of science born out of Science, Technology, Engineering and Mathematics (STEM). STEM encompasses and embrace a variety of subjects or discipline that falls into each of the term in the acronym STEM; some of this subjects include physics, chemistry, biology, astronomy, astrophysics, biochemistry, chemical engineering, Nanoscience and Nanotechnology, robotics, computer science, aerospace engineering and many more.

Nanoscience and Nanotechnology is a multi- disciplinary field that includes chemistry, physics, biology, material science and engineering (Ernst, 2009; Gardner, Jones, & Falvo, 2009). It is the science of small and ultra-small things (Cavanagh, 2009). Nanoscience and Nanotechnology (NSNT) can be taught in physics, chemistry, biology, engineering, material sciences, medicine and pharmaceutics. The inclusion of fundamental aspects of NSNT in the classroom or educational sector may address, for example, the physical world of size, force, properties and time. Furthermore, it could also address the dimensional aspects of nanostructure, one-dimensional space like thin film, two-dimensional space like nanotubes or three-dimensional space like quantum dots (Asmatulu & Misak, 2011, Luisa & Duncan, 2012). The concept of Nanoscience and Nanotechnology is attributed to Nobel Prize Winner Richard Feynman (1960) who stated that "there is plenty of room at the bottom proposed a new field of manipulating and controlling substance on a small scale called Nanoscale". His work, viewpoint and knowledge about the Nano and Nanoscale gave birth to the development of Nanoscience and Nanotechnology.

Awareness is the ability to directly know and perceive, to feel, or to be cognizant of events. More broadly, it is the state of being conscious of something (Smith, 2011). The level of awareness about a relatively new field like Nanoscience and Nanotechnology depends critically, among other factors, upon: the literacy rate of the population, Awareness created among different segments of the society by the scientific community through different channels of communication and the general attitude of the public towards technical innovations.

The need to raise public and professional awareness of Nanoscience and Nanotechnology (NSNT) has been assessed in a number of studies (Batt, Waldron & Broadwater 2008, Craig, 2009). However, none of these studies probed the level of awareness of science teachers about Nanoscience and Nanotechnology in science and Technical schools and how to teach NSNT and its fundamental ideas in the classroom. The awareness of science teachers about Nanoscience and Nanotechnology on its fundamental ideas becomes highly necessary. Furthermore, scholars have identified nine fundamental ideas which Nanoscience and Nanotechnology is based on. These nine big ideas include: Size and Scale, Structure of Matter, Forces and Interactions, Quantum Effects, Size-Dependent Properties, Self-Assembly, Tools and Instrumentation, Models and Simulations, Science, Technology and Society (Stevens, Sutherland & Krajcik, 2009).

The aforementioned fundamental ideas of NSNT are reflected or contained in the current curriculum of science and Technical schools in Nigeria. Based on these Ideas it is possible to teach Nanoscience and Nanotechnology in Science and Technical Schools in order to facilitate a teaching learning sequence for Science and Technical schools' students.

The rapid development and growing societal importance of Nanoscience and Nanotechnology (NSNT) have evoked educational concerns throughout the world. In the past two decades a growing body of science education research has been carried out concerning NSNT issues (Hingant & Albe 2010, Jones, Blonder, Gardner, Albe, Falvo & Chevrier, 2013). The United States of America for example recognized the important role of NSNT in Science and Society, the US National Science Foundation (NSF) funded a series of workshops in order to work out basic teaching ideas of the Nanoscience field.

Fazarro, Newberry, Trybula and Hyder (2012) opined that Science and the application of scientific knowledge at the Nanoscale will affect every market segment within the next decade. This scientific knowledge and technical skills needed by science students in Science and Technical schools can only be provided by science teachers who are aware and well informed about NSNT and have the capacity to decipher it.

As a consequence of this development, it has been frequently recommended that Nanoscience and Nanotechnology Education be provided at different levels of Education. These demands have been made from a variety of viewpoints of advocates, including governments and public administrations, industry and commerce, civic organizations, Nanoscientists and engineers, science and technology educators, and social scientists (European Commission, 2010; Healy, 2009). The most common concern is the impending lack of researchers, science teachers, engineers and other professionals with specialization in Nanoscience and Nanotechnology. In many cases, however, the need for NSNT Education has been expressed with reference to scientific and/or technological literacy (Zenner & Crone, 2008; Stevens *et al.*, 2009), on concepts that have remained highly influential in curriculum development projects worldwide (Holbrook, 2010). The basic idea in these claims is that all citizens will soon need some kind of Nanoscience and Nanotechnology Education or "Nano-literacy" in order to navigate some of the important science-based issues related to their everyday lives and society.

Hence, it is therefore important to carry out study on awareness of science teachers in science and technical schools about Nanoscience and Nanotechnology in F.C.T Abuja

Statement of the Problem

Many countries of the world have considered incorporating Nanoscience and Nanotechnology into their science curriculum because of its great potentials and prospects in the 21st century. Scientists confirm that Nanoscience and Nanotechnology (NSNT) will result in a new scientific revolution called the fourth industrial revolution. The need to raise student and academic staffs awareness about NSNT has been assessed in a number of studies Elmarzugi, Keleb, Mohammed, Benyones, Bendala, Mehemed and Eid,(2014), Ahmed, Imdad, Yaldram and Raza,(2015). However, none of these studies probed into the knowledge of the level of awareness of science teachers about Nanoscience and Nanotechnology in science and Technical schools and its fundamental ideas in the classroom. The awareness of science teachers about Nanoscience and Nanotechnology, its fundamental ideas and disciplinary content and knowledge becomes highly necessary. Nigeria a developing country should not be left behind in the field of Nanoscience and Nanotechnology (NSNT) Education at the secondary school level. Traditional science disciplines or subject such as physics, chemistry and biology have become too specialized, in the current science curriculum in science and technical schools in Nigeria and there is less space and time for teachers to teach NSNT and reflect the fundamental ideas of Nanoscience and Nanotechnology using the Nano concept and Nanoscale in the classroom. The fundamental ideas of Nanoscience and Nanotechnology (NSNT) have been identified by some Scholars, Scientists, Nanoscientists, Science Educators and Researchers to have a multidisciplinary, interdisciplinary and Transdisciplinary perspective. The challenge before science teachers is that should NSNT be taught in the classroom as a multidisciplinary, interdisciplinary or Trans disciplinary modus. Identifying what concepts to teach is the job of the syllabus or curriculum, but the nature and structure of each concept, and how connected concepts relate to the real world, are generally poorly defined and are left up to the teacher to decipher. Knowledge of disciplinary content, how to present and scaffold information, and understanding about NSNT needs of students and the individuals within each class characterizes the complex, interwoven practice of teaching. Hence it is also important in the context of exploring implications for teaching and learning to reflect and represents a significant shift in the way NSNT should be taught. The awareness of science teachers about Nanoscience and Nanotechnology and its disciplinary perspective becomes highly necessary.

Objectives of the Study

The study aimed to achieve the following objectives

(i) To determine the level of awareness of science teachers about Nanoscience and Nanotechnology (NSNT).

(ii) To determine if science teachers are aware of the fundamental ideas of Nanoscience and Nanotechnology (NSNT).

Research Questions

1. What is the level of awareness of Science teachers about Nanoscience and Nanotechnology?
2. What is the level of awareness of Science teachers about the fundamental ideas upon which Nanoscience and Nanotechnology is based on?

Research Hypotheses

The study tested the following null hypotheses at 0.05 levels of significances:

H_{O1}: There is no significant difference in awareness of Science teachers' about Nanoscience and Nanotechnology.

H_{O2}: There is no significant difference in awareness of Science teachers' about the fundamental ideas upon which Nanoscience and Nanotechnology is based upon.

Methodology

A survey research design was used to find out the level of awareness of science teachers about Nanoscience and Nanotechnology (NSNT) in science and technical school in Abuja. The population consisted of 224 science teachers (136 Males and 88 Females) from all the five (5) Science and Technical Schools in the six (6) municipal councils of the Federal capital territory (FCT) Abuja. Purposive sampling techniques was used for selecting the schools for the study since the schools are few, widely spread across the various municipal councils in the Federal Capital Territory (FCT) Abuja. The entire population of 224 Science teachers was used as the sample size for the study (Ibrahim, 2013) since they can be conveniently covered, there was no need sampling the respondents for the study. The instrument for data collection was the questionnaire on awareness of Science teachers about Nanoscience and Nanotechnology in Science and Technical schools (AOSTANSNTQ) with reliability coefficient of 0.96 was used for the study. Simple percentage and frequency counts were used to answer the research question while Analysis of variance (ANOVA) was used to test the hypothesis.

Results

Table 1: % Response of Science Teachers Level of Awareness about Nanoscience and Nanotechnology

S/N	STATEMENT	Negative response (N.A)	% Negative response	Moderate response (M.A)	% Moderate response	Positive response (A+H.A)	% Positive response
		F	%	F	%	F	%
1.	I have heard about the term Nanoscience and Nanotechnology	140	75.3	3	1.6	43	23.1
2.	I have not heard about Nanoscience and nanotechnology	179	96.2	1	0.5	6	3.2
3.	Science teachers are aware of Nanoscience and Nanotechnology	145	78.0	6	3.2	35	18.8
4.	Science teachers are not aware of Nanoscience and Nanotechnology	171	91.9	8	4.3	7	3.8
5.	Nanoscience and Nanotechnology cut across traditional sciences such as Physics, Chemistry, Biology, material science and so on.	138	74.2	6	3.2	42	22.6
6.	Nanoscience and Nanotechnology do not cut	179	96.2	4	2.2	3	1.6

	across traditional sciences such as Physics, Chemistry, Biology, material science and so on.						
7.	The Nano is equivalent to one billionth $\frac{1}{1000,000,000}$ or 10^{-9}	135	72.6	0	0	51	27.4
8.	The Nano is not equivalent to one billionth $\frac{1}{1000,000,000}$ or 10^{-9}	186	100	0	0	0	0
9.	The nanometer is equivalent to one billionth of a meter $\frac{1}{1000,000,000}$ m or 10^{-9}m?	135	72.6	0	0	51	27.4
10.	The nanometer is not equivalent to one billionth of a meter $\frac{1}{1000,000,000}$ m or 10^{-9}m?	185	99.5	0	0	1	0.5
	Average % of positive, moderate and negative response	**85.65**		**1.50**		**12.84**	

Table 1 shows the percentage analysis of science teachers' awareness about Nanoscience and Nanotechnology positive, moderate and negative responses. The average percentage of positive, negative and moderate responses on awareness about Nanoscience and Nanotechnology are 12.84%, 85.65% and 1.50%. This indicates that science teachers in science and technical schools are not aware of Nanoscience and Nanotechnology.

Table 2: % Response of Science Teachers Level of Awareness about the fundamental Ideas Upon which Nanoscience and Nanotechnology is Based On

S/N	STATEMENT	Negative response (N.A)	% Negative response	Moderate response (M.A)	% Moderate response	Positive response (A+H.A)	% Positive response
		F	%	F	%	F	%
1.	Science teachers are aware of the fundamental ideas of Nanoscience and Nanotechnology	136	73.1	6	3.2	44	22.7
2.	Science teachers are not aware of the fundamental ideas of Nanoscience and Nanotechnology	177	95.2	8	4.3	1	0.5
3.	The fundamental ideas of Nanoscience and Nanotechnology cuts across	136	73.1	5	2.7	45	24.2

	traditional science such as Physic, Chemistry, Biology and many more.						
4.	The fundamental ideas of Nanoscience and Nanotechnology do not cuts across traditional science such as Physic, Chemistry, Biology and many more.	180	96.8	5	2.7	1	0.5
5.	The fundamental ideas of Nanoscience and Nanotechnology are interdisciplinary	135	72.6	5	2.7	46	24.8
6.	The fundamental ideas of Nanoscience and Nanotechnology are not interdisciplinary	178	95.7	8	4.3	0	0
7.	The fundamental ideas of Nanoscience and Nanotechnology do not cut across traditional science	173	93.6	10	5.4	3	1.6
8.	The fundamental ideas of Nanoscience and Nanotechnology present a challenge to curriculum planners, designers and developers	151	81.2		3.2	29	15.6
9.	The fundamental ideas of Nanoscience and Nanotechnology do not present a challenge to curriculum planners, designers and developers	170	91.4	5	2.7	11	5.9
10.	The interdisciplinary nature of the fundamental ideas of Nanoscience and Nanotechnology calls for curriculum inclusion of Nanoscience and Nanotechnology	140	75.3	4	2.2	42	22.6
11.	The interdisciplinary nature of the fundamental ideas of Nanoscience and Nanotechnology does not calls for curriculum inclusion of Nanoscience and Nanotechnology	178	95.7	4	2.2	4	2.2
12.	The ideas of Nanoscience and Nanotechnology are the fundamental basis for	139	74.7	8	4.3	40	21

	Nanoscience and Nanotechnology						
13.	The ideas of Nanoscience and Nanotechnology are not the fundamental basis for Nanoscience and Nanotechnology	179	96.2	3	1.6	4	2.2
	Average % of positive, negative and moderate responses		**85.70**			**3.20**	**11.1**

Table 2 shows the percentage analysis of science teachers' awareness about the fundamental ideas of Nanoscience and Nanotechnology positive, moderate and negative responses. The average percentage of positive, negative and moderate responses on awareness about the fundamental ideas of Nanoscience and Nanotechnology are 11.1%, 85.70% and 3.20%. This indicates that science teachers in science and technical schools are not aware of the fundamental ideas upon which Nanoscience and Nanotechnology is based on.

Table 3: ANOVA comparison of the level of awareness of Science teachers about Nanoscience and Nanotechnology

Source variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	731.298	5	146.260	3.653	.004
Within Groups	7206.164	180	40.034		
Total	7937.462	185			

Table 3 presents ANOVA results of the level of awareness of Science teachers about Nanoscience and Nanotechnology. The result yielded an F- value of 3.653 and a P-value of 0.004 ($P<0.05$). The result shows that there was statistically significant difference in awareness of Science teachers about Nanoscience and Nanotechnology because $P<0.05$. Therefore hypothesis one (HO_1) was rejected.

Table 4: ANOVA comparison of the level of awareness of Science teachers about the fundamental ideas upon which Nanoscience and Nanotechnology is based on

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	869.931	5	173.986	2.956	.014
Within Groups	10595.730	180	58.865		
Total	11465.661	185			

Table 4 presents ANOVA results of the level of awareness of Science teachers' about the fundamental ideas upon which Nanoscience and Nanotechnology is based on. The result yielded an F- value of 2.956 and a P-value of 0.014 ($P<0.05$). The result shows that there was statistically significant difference in awareness of Science teachers' about the fundamental ideas upon which Nanoscience and Nanotechnology is based on because $P<0.05$. Therefore hypothesis two (HO_2) was rejected.

Discussion of Findings

The findings of the study on the awareness of science teachers about Nanoscience and Nanotechnology in Abuja revealed a low level of awareness of science teachers' about Nanoscience and Nanotechnology (NSNT). This study is not in concurrence with the findings of Ahmed, Imdad, Yaldram and Raza,(2015) who examined the level of awareness and the attitude towards Nanotechnology (NT) among the students and teachers of some higher Educational institutions of Islamabad, Pakistan which revealed a high level of awareness about Nanoscience and Nanotechnology both among teachers and students. The findings of the study on the awareness of science teachers about the fundamental ideas upon which Nanoscience and Nanotechnology (NSNT) is based on also revealed a low level of awareness about the fundamental ideas of Nanoscience and Nanotechnology among science teacher. This is a true reflection of the low level of awareness of science teachers' about Nanoscience and Nanotechnology (NSNT). This study is not in concurrence with the findings of Laherto (2011) on Incorporating Nanoscale science and technology into Finnish secondary school curriculum in which all the respondents in the study are aware of the fundamental ideas upon which Nanoscience and Nanotechnology (NSNT) is based on as pointed out essentially as the "Big Ideas" of NSNT by Stevens *et al*. (2009).

Conclusion

In conclusion it is possible to introduce and teach Nanoscience and Nanotechnology (NSNT) at the secondary school level to increase students' understanding of nano-related science concepts and to promote Nanoscience literacy.

Science teachers need professional development to help those finding ways to teach and connect Nanoscience and Nanotechnology in the existing science curricula and syllabus. This can be done by specific guidance of making connections between new and old topics, and by showing exactly where and how in the curriculum the new concepts can be embedded.

In addition, science teachers need professional development to provide instructional materials, workbooks and technology and to help in finding ways how to use the new materials to teach Nanoscience and Nanotechnology concepts in the classroom.

Recommendations

Based on the findings of the results of the study, the following recommendations were made.

1. Nanoscience and Nanotechnology (NSNT) should be taught in the classroom either in any of the three (3) perspectives; interdisciplinary, multidisciplinary and Transdisciplinary perspective.
2. Nanoscience and Nanotechnology (NSNT) can also be taught in the classroom as a subject on its own in secondary schools and science and technical colleges.
3. The current science curriculum and syllabus should expand the scope of NSNT in secondary schools and science and technical colleges beyond the 9^{th} fundamental idea.
4. Policies and strategies should be developed to encourage and motivate science teachers' in secondary schools and science and technical colleges to teach NSNT in the classroom.

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