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Determinants of Awareness Levels of Physics Teachers about Nanoscience and Nanotechnology (NSNT) in Senior Secondary Schools: Oyo Educational Zone Experience

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Abstract

The rapid development and impact of nanoscience and nanotechnology (NSNT) on economy has led policy makers and educators to focus on nanotechnology education. This study examined the determinants of awareness levels of physics teachers about Nanoscience and Nanotechnology (NSNT) in senior secondary schools. The study was guided by five research hypotheses. The adopted descriptive survey design was carried out in forty-one secondary schools in four local government area of Oyo metropolis in Oyo State. Out of which twenty-two were public secondary schools and nineteen were private secondary schools. One physics teacher was selected from each school. Data was collected using a questionnaire titled Nanoscience and Nanotechnology Awareness Questionnaire (NSNTAQ) and presented using frequency counts, simple percentage and chi-square. The findings of the study reveal that: majority of the participants have awareness about Nanoscience and Nanotechnology and the level of awareness of the participants was independent on their genders, age, qualification, working experience, and the type of school that they are working. It is strongly recommended comrehensive in-service training for physics teachers for sustainability of the good awareness, exposure and knowledge if Nanoscience and Nanotechnology is to be included in the curriculum.

Keywords: Awareness, Teacher, Nanoscience, Experience, Schools, Qualification.

Introduction

Nanoscience is one of the most speedily growing fields in science, technology, life sciences and engineering research: energy production, environmental protection, nanotechnology-related medicine, education and national security. Nanotechnology includes designing, producing, using industry areas in textile, cosmetics, electronics from nanomaterials to nano intermediates to nano- enabled products (Foley and Hersam, 2006; Jackman et al. 2016; OECD, 2018). The study of quanta in Physics will be better understood with the knowledge of nanoscience and nanotechnology.

Soon, the nanotechnology level of a country will be anticipated to be a noticeable pointer of economic strength. In addition, nanotechnology is being spoken of as the driving force responsible for a new industrial revolution and is one of the "Key Enabling Technologies" of the European Union (URL). The quick development and influence of nanoscience and nanotechnology (NSNT) on economy has led policy makers and educators to concentrate on nanotechnology education (Laherto, 2010). The potential result of NSNT made these fields a critically significant part of everyday life, to uplifting quality of life. The big picture is positive developments and commercialization, adoption of new technologies resulting from nanoscale are expected to impact economic growth. A positive economic return in the form of benefits such as the creation of businesses, jobs, boost competitiveness and trade while supporting growth and sustainability are expected.

Awareness gaps exist in secondary teacher training for NSNT education since the first stage of awareness, attitudes, and knowledge levels of teachers should be determined with a need assessment. Only then more training, skills to be developed, qualifications can be planned, and effective programs developed. Literature contends studies mostly on case-by-case teaching and learning strategies to various target groups: teachers (Sgouros and Stavrou, 2019), engineers (Samal and Bharati, 2019; Vahedi and Farnoud, 2019), other professionals (non-science majors: Park, 2019), students including primary (Mandrikas, Michailidi and Stavrou, 2019) and secondary education (Stravou, et al. 2015; Ribeiro, et al. 2018; Lati, Triampo, and Yodyingyong, 2019; Tirre, et al. 2019). Majority of the literature report development of teaching modules, design of experiments; however, have not considered the awareness level of teachers. Teacher, student and higher education student interactions with nanoscientists from

academia, industry and institutions can bridge the gap between nano education and expectations of the job market. Several studies have shown that visual techniques such as models, applicable activities, simulations, movies, game-based learning, experiments, visual nanotechnology laboratory, etc. are effective to simplify the teaching of NSNT topics (Blonder and Sakhnini, 2012; Furlan, 2009; Gorghiu, Gorghiu, and Petrescu, 2017; Alpat, et al. 2017; Lu and Sung, 2011; Tarng, et al. 2011; Zor and Aslan, 2018). The use of interactive learning videos consisting of attractive visuals on NSNT added with online learning activities that support teaching innovations in the field of nanoscience (Xie and Lee, 2012). Nandiyanto et al., (2018) reported that additional attractive experimental demonstration improves the level of students' comprehension and helps teachers to teach the subject.

Statement of the problem

Nanoscience and Nanotechnology (NSNT) are related to Physics Education, but how much of NSNT are being taught in the secondary schools by the teachers, are the Physics teachers aware of this NSNT? Therefore, the study investigated the awareness level and determinants of awareness level of physics teachers about NSNT in secondary schools.

Objective of the study

The objectives of this research are to determine the effect of:

1. teachers' gender on their awareness about nanoscience and nanotechnology;
2. teachers' age on their awareness about nanoscience and nanotechnology;
3. teachers' qualification on their awareness about nanoscience and nanotechnology;
4. teachers' years of working experience on their awareness about nanoscience and nanotechnology;
5. type of school on the awareness of teachers about nanoscience and nanotechnology;

Research Hypothesis

These hypotheses are formulated for the study.

H_{o1}: Gender would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

H_{o2}: Age would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

H_{o3}: Qualification would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

H_{o4}: Years of working experience would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

H_{o5}: Type of school would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

METHODOLOGY

The research design adopted for the study was descriptive design. This design is considered appropriate because it enables the researcher to generate data through the standardized collection procedures based on highly structured research instruments and well-defined study concepts and related variables.

A purposive sampling of eleven (11) Secondary Schools physics teachers are from one local government while ten (10) physics teachers are from each of the other three Local government area of Oyo State making a total of 41 Secondary Schools physics teachers were employed. A simple random sampling technique was engaged to Select one (1) respondent in each schools selected. The study made use of forty-one (41) respondents (physics teachers) in all.

The instrument used for the study is a questionnaire designed to collect information from the respondents titled Nanoscience and Nanotechnology Awareness Questionnaire (NSNTAQ). The questionnaire consists of two sections. Section A consists of personal and demographic information which include age range, gender, qualification, years of working experience and type of school. Section B investigated the awareness levels of physics teachers about Nanoscience and Nanotechnology in Senior Secondary School. Data was collected using a two (2) points Likert scaled questionnaire.

To ensure validity of the instrument the questionnaire was subjected to peer-review by professionals. The reliability of the instrument was examined using Cronbach Alpha reliability coefficient. Although, many experts over the years has adjudge that questionnaire is one of the best instrument for data collection. The reliability of items of questionnaire examined for Section B was 0.88 affirming the reliability of the instrument.

Permission and approval were sought from both principal and the vice principal of the above aforementioned schools for the personal administration of the questionnaire in those schools. The researcher administered the instrument to respondents and wait for immediate collection.

The data collected was analyzed using frequency counts and simple percentages for the demographic variables while research hypothesis was approached using chi- Square test of Association and independence.

RESULT AND DISCUSSION

Table 1: Analysis of Data Based on Demographic information of the respondents

Parameters	Classification	Frequency	Percentage
Gender	**Male**	27	65.9
	Female	14	34.1
	Total	**41**	**100.0**
Age	Less than 30	23	56.1

	30-39	13	31.7
	40 years and above	5	12.2
	Total	**41**	**100.0**
Qualification	OND Certificate	1	2.4
	NCE Certificate	2	4.9
	HND	2	4.9
	PGDE	1	2.4
	B.Sc(Ed)	23	56.1
	M.Sc	11	26.8
	B.TECH	1	2.4
	Total	**41**	**100.0**
Years of working experience	1-10 years	21	51.2
	11-20 years	16	39.0
	21-30 years	3	7.3
	30-35 years	1	2.4
	Total	**41**	**100.0**
Local Government Area	Atiba	10	24.4
	Oyo west	11	26.8
	Afijio	10	24.4
	Oyo east	10	24.4
	Total	**41**	**100.0**
Type of School	Public	22	53.7
	Private	19	46.3
	Total	**41**	**100.0**

Table 1 revealed that majority 65.5% of respondent were Male while Female accounted for 34.1% respectively. The highest percentage 56.1% of respondent were in the age group less than 30 years followed by 31.7% who were in the age group of 30-39 years and 12.2% were above 40 years of age. Futhermore,56.1% of respondents had B.Sc. (Ed) qualification,26.8% of respondents had M.Sc. qualification,4.9% had NCE Certification and HND Certification qualification while 2.4% of respondents had OND, PGDE and B. TECH respectively. 51.2% of the respondents had 1-10 years of working experience, followed by 39.0% which had 11-20 years of working experience,7.3% of respondents had 21-30 years of working experience and 2.4% had 30-35 years of working experience.

Majority 26.8% of the respondent are from Oyo west Local Government and 24.4% of respondents are from Atiba, Afijo and Oyo East Local Government respectively. The highest percentage 53.7% of the respondents are from Public schools and 46.3% are from Private school.

Table 2: Awareness level of physics teachers

ITEMS	STATEMENTS	YES N(%)	NO N(%)	MEDIAN
1.	Atoms and molecules are the building blocks of all living things and all the materials we use.	38(92.7)	03(7.3)	1.00
2.	A nanometer is 1/1,000,000,000(one-billionth) of a meter (10^-9m)	32(80.5)	09(19.5)	1.00
3.	A nanomaterial is an object that has less than one dimension in the nanometre scale	28(68.1)	13(31.9)	1.00
4.	Viruses are examples of intentionally made nanomaterials	31(75.6)	10(24.4)	1.00
5.	Nanomaterials are larger than single atoms but smaller than bacteria and cells	29(70.7)	12(29.3)	1.00
6.	A Human hair is about 80,000nm in diameter	29(70.7)	12(29.3)	1.00
7.	Macro objects are smaller than nanoscale objects	28(68.1)	13(31.9)	1.00
8.	Nanoscale objects are visible to the naked eye	17(41.5)	24(58.5)	2.00

Source: Field Survey (2022)

Table 2 revealed the awareness levels of Physics teacher about NSNT teaching process in formal Physics courses in Nigeria. The table revealed that the highest percentage of 92.7% of the respondent were aware that Atoms and molecules are the building blocks of all living things and all the materials we use while 7.3% were not aware. The higher percentage of 80.5 of the respondent knows that nanometer is 1/1,000,000,000(one-billionth) of a meter (10^-9m) and 19.5% not knows. 68.1% of the respondent were taught that nanomaterial is an object that has less than one dimension in the nanometer scale, and 31.9% were not. 75.6% of respondent aware that viruses are examples of intentionally made nanomaterials while 24.4% were not. The higher percentage of 70.7% of the respondent knows that nanomaterials are larger than single atoms but smaller than bacteria and cells and 29.3% were not. 70.7% of the respondent knows that human hair is about 80,000nm in diameter and 29.3% were not know. The higher

percentage of 68.1% of respondent were not aware that macro objects are not smaller than nanoscale objects while 31.9 were aware. 41.4% of the respondent were not informed that nanoscale objects are not visible to the naked eye and 58.5% were informed.

Hypothesis Testing

Hypothesis One

H_{o1}: Gender would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

Table 3: Impact of gender on awareness level of physics teachers

Awareness levels of physics teachers about NSNT teaching process in formal physics courses in Nigeria						
		Yes (%)	**No (%)**	**X^2-Value**	**Df**	**P-Value**
Sex	Male	17.0(17.0)	10.0(10.0)	2.440[a]	3	.295
	Female	12.0(12.0)	2.0(2.0)			
	Total	**29.0(29.0)**				
			12.0(12.0)			

Decision: Since both the p-value (0.295) is greater than Alpha-Value (0.05) and the X^2-Value(2.440[a]) is less than the tabulated Chi-Square value at 3 degree of freedom. It is therefore concluded that Awareness is independent on gender.

Hypothesis Two

H_{o2}: Age would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

Table 4: Impact of age on awareness level of physics teachers

Awareness levels of physics teachers about NSNT teaching process in formal physics courses in Nigeria						
		Yes (%)	**No (%)**	**X^2-Value**	**Df**	**P-Value**
Age	Less Than 30 years	15.0(15.0)	8.0(8.0)	2.387[a]	4	.665
	30-39 years	11.0(11.0)	2.0(2.0)			
	40 years and above	3.0(3.0)	2.0(2.0)			

	Total	**29.0(29.0)**	**12.0(12.0)**			

Decision: Since both the p-value (0.665) is greater than Alpha-Value (0.05) and the X^2-Value(2.387^a) is less than the tabulated Chi-Square value at 4 degree of freedom. It is therefore concluded that Awareness is independent on Age.

Hypothesis Three:

H_{o3}: Qualification would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

Table 5: Impact of qualification on the awareness level of physics teachers

Awareness levels of physics teachers about NSNT teaching process in formal physics courses in Nigeria						
		Yes (%)	**No (%)**	**X^2-Value**	**df**	**P-Value**
Qualification	OND	1.0(1.0)	0.0(0.0)	7.441^a	12	.827
	NCE	1.0(1.0)	1.0(1.0)			
	HND	1.0(1.0)	1.0(1.0)			
	PGDE	0.0(0.0)	1.0(1.0)			
	B.Sc.	15.0(15.0)	8.0(8.0)			
	M.Sc.	10.0(10.0)				
	BTech	1.0(1.0)	1.0(1.0)			
			0.0(0.0)			
	Total	**29.0(29.0**	**12.0(12.0)**			

Decision: Since both the p-value (0.827) is greater than Alpha-Value (0.05) and the X^2-Value(7.441^a) is less than the tabulated Chi-Square value at 12 degree of freedom. It is therefore concluded that Awareness is independent on Qualification.

Hypothesis Four:

H_{o4}: Years of working experience would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

Table 6: Impact of years of working experience on the awareness level of physics teachers

Awareness levels of physics teachers about NSNT teaching process in formal physics courses in Nigeria						
		Yes (%)	**No (%)**	**X^2-Value**	**Df**	**P-Value**
Years of working Experience	1-10years	12.0(12.0)	9.0(9.0)	18.2887^a	5	.006
	11-20 years	14.0(14.0)	2.0(2.0)			
	21-30 years	2.0(3.0)	1.0(1.0)			

31-35	1.0(1.0)		
		0.0(0.0)	
Total	**29.0(29.0**		
		12.0(12.0)	

Decision: Since both the p-value (0.06) is greater than Alpha-Value (0.05) and the X^2-Value(18.2887[a]) is less than the tabulated Chi-Square value at 5 degree of freedom. It is therefore concluded that Awareness is independent on years of working Experience.

Hypothesis Five:

H_{o5}: Type of school would not significantly influence awareness level of physics teachers about nanoscience and nanotechnology.

Table 4.7: Impact of qualification on the awareness level of physics teachers

Awareness levels of physics teachers about NSNT teaching process in formal physics courses in Nigeria						
		Yes (%)	**No (%)**	**X^2-Value**	**df**	**P-Value**
Types of school	Public	15.0(15.0)	7.0(7.0)	1.642[a]	2	.440
	Private	14.0(14.0)	5.0(5.0)			
	Total	**29.0(29.0)**				
			12.0(12.0)			

Decision: Since both the p-value (0.440) is greater than Alpha-Value (0.05) and the X^2-Value(1.642[a]) is less than the tabulated Chi-Square value at 2 degree of freedom. It is therefore concluded that Awareness is independent on types of school.

Discussion of Findings

This finding shows that majority of the participants have awareness about Nanoscience and Nanotechnology. This study is in concurrence with the findings of Ahmed, et al., (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. In most studies, it has been observed that awareness of nanoscience and nanotechnology has not been created and individuals have insufficient knowledge about it (Elmarzugi et al.,2014; Enil and Köseoğlu, 2016; Şenocak, 2014).

As a result of the analyses in which the awareness level of the physics teachers about nanoscience and nanotechnology in terms of their gender was analyzed, awareness level is independent on gender. Alpat et al. (2017) determined in their study that there is no significant difference between knowledge on nanotechnology and female and

male students. İpek et al. (2020) concluded in their study that there is a difference between the knowledge of males and females on nanotechnology, but that awareness of the males was higher compared to the females.

It was determined that awareness level of physics teacher about nanoscience and nanotechnology is independent on their qualifications while in some studies, it was concluded that the education level of the science teachers is influential on their awareness. These results are not in line with Vandermoere et al. (2010) who examined public attitudes towards and awareness of nanotechnology in Germany.

Awareness level of physics teachers about nanoscience and nanotechnology is independent on years of working experience and their age. Young teachers, 1-10 years of working experience, had more exposure and knowledge about NSNT; may have reflected these as excitement or motivation and idealistic thoughts. This may also be supported with interest in science and technology developments. Therefore, teachers who have gained experience to participate in seminars, conferences, presentations, in-service training activities or courses in the early years of their profession may have more information on NSNT topics. Teachers who have 11-20 years of professional experience are very experienced in their fields, are more confident, have been under inquiry from interested students, had observed more research and experiments; prepared for research, projects, and gaining NSNT knowledge.

Finally, awareness level of physics teachers about nanoscience and nanotechnology is independent on types of school. Public school physics teachers' NSNT awareness level was the same with the private school physics teachers. They updated and developed their skills and knowledge to meet high student expectations such as project work, problem solving and analytical thinking. Also, high profile and self-efficacy perceptions of teachers and students in this school type may have contributed.

Recommendations

This research work, hence recommend in-service training for physics teachers for sustainability of the good awareness, exposure and knowledge if Nanoscience and Nanotechnology is to be included in the curriculum.

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