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The Awareness Level and Perception of Secondary School Physics Teachers towards Nanotechnology in Rivers State

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

This paper adopted a descriptive design to investigate the awareness level and the perception of secondary school Physics teachers towards Nanotechnology in Port Harcourt Metropolis of Rivers State. The population of the study was 43 physics teachers comprising of 25 male and 18 female which was used from the 12 public secondary schools in Port Harcourt Metropolis in Rivers State. The instrument for the study was a self- made questionnaire titled, Nanotechnology Questionnaire on Awareness and Perception for Teachers (NQAPT) with a reliability of 0.85 obtained using Cronbach Alpha reliability formula. Two research questions and two null hypotheses guided the study. The research questions were answered using the criterion mean of 2.5 and standard deviation, while the null hypotheses were tested at 0.05 level of significance using t- test. The findings revealed that the awareness level of Nanotechnology among teacher was low and their perception towards nanotechnology was positive. There is no significant difference between the awareness level and perception of the concept of Nanotechnology among male and female senior secondary school Physics teachers. Based on these findings, it is recommended that more awareness on the concept of Nanotechnology be created among secondary school teachers through symposium and science teaching workshop in order to publicize the benefits of nanotechnology to the society.

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1. INTRODUCTION

Science education creates awareness to the development of a nation through exploration of technology. Physics as a science subject deals with energy and matter, and the interactions between them where energy is regarded to be continuous or discrete. The contribution of Physics to national development cannot be overemphasized, more especially as it has given birth to new technologies. Physics has so many branches which are useful for technological development and end-use varieties for social benefits - the conservation of space, time and motion, conservation of principles, waves, fields and quanta. The objectives of Physics are:

1. Provide basic literacy in physics for functional living in the society.
2. Promote the acquisition of skills for technology and innovation and
3. To stimulate and enhance creativity [1].

The study of quanta in Physics will be better understood with the knowledge of nanotechnology. Santiago and Morell [2] defines Nanotechnology as an interdisciplinary field of research that deals with the development of only very small materials, devices and systems which function through the atomic scale, which is the nanometre length scale. When compared to the human hair, it is about 10 thousand nanometre. The size of a sheet of paper (100000 nm 10^{-3}m) can be used to describe the actual size of nanotechnology. Not only has this study helped in physics, it has helped in the teaching and learning of atoms and molecules more especially as it aids the study of very tiny particles. Most of the instruments used are developed with the Nano scale. The concept of nanotechnology have some relationship with measurement especially that of measurement of length metres (m), kilometre (km), centimetre (cm), millimetre (mm) as embedded in Nigerian Physics Curriculum. These measurements are carried out using the micrometer screw guage, vernier callipers and metre rule, with graduation scales larger than that of the Nano scale. Most students with background in Physics could apply the appropriate technique and unit to the measurements of larger instrument using metre rule to measure length, chemical balance for mass, graduated beaker and cylinder for volume calibrated with the appropriate unit. However, it is necessary for the students and teachers to be enlightened about measurement using Nano scale in nanotechnology. As Nanotechnology according to Sherma et al. [3] are the concept which leads to the study of the characteristics of Nano scale (1-100 nm) which is very small. The size is about 1-100 Nano meter which is 10^{-9} m. 1nanometer (nm) = 0.000000001 meter (m).

Nanotechnology is important, since it propels new philosophical and sociological challenges. It is expedient that the students be aware of these changes through effective teaching. However, are the teachers aware of this technology? As nanotechnology is creating awareness, Nano scale research and Nano science is also a focus. As they relate the properties of matter and interaction at the atomic scale. Nanotechnology has recently involved in developing new technology such as human genome projects, cloning and carbon nanotubes. The knowledge will help the design and fabrication of diamond computer chips, thus reducing the price of production of computers. Nanotechnology is very useful in health care, where molecular size devices that could treat or destroy some kind of cells, tissues are produced. Most developed countries invest billions of naira into Nanotechnology. With the usefulness of the nanotechnology, it is important to create it's awareness to schools especially in the secondary schools where science subjects are taught to students. Santiago and Morell [2] also emphasised the need for teachers to instruct their students to be aware of this new paradigm shift to nanotechnology, in order for the society to be a partaker of its numerous benefits.

The theory guiding this study is hinged on Gagne [4], which states that anyone can learn anything, provided the learner has a prerequisite knowledge. This knowledge will enable the learner understand and construct their own learning from the past and current experiences. Thus a learner can construct nanotechnology content from the prior knowledge acquired in Physics concept. It is therefore imperative to imply the prior knowledge from physics measurement concept when teaching the principles of Nanotechnology. This study, would give information on how technology would be used to boast the economy of the nation. It will enable curriculum planners to consider, integrating nanotechnology to the physics curriculum and will be useful to other field of

study such as Engineering, medicine, biochemistry and physical sciences.

Awareness of Nanotechnology: Santiago and Morell [2] revealed that Feynman the American Physicist and Nobel Laureate was the first to conceive Nanotechnology and emphasised that someday the current devices and materials would be produced to specification. The knowledge of Nanotechnology is beginning to gain insight in Nigeria. In 1992, the government established science agencies such as National Agency for Science and Engineering Infrastructure (NASENI) in order to improve the nation's wealth. According to naseni.org 2019, there is emphasis on the need to strengthen the science education sector and to create the awareness of nanotechnology and improve learning of the sciences in schools to ensure hands-on activities are being practiced in schools. The government has tried to create the awareness of Nano science by establishing developmental centres such as:

1. Scientific Equipment Development Institutes (SEDI) sited in Enugu and Minna.
2. National Engineering Design Development Institute (NEDDI), Nnewi.
3. Power Equipment and Electrical Machines Development (PEEMADI), Okene and others.

There are still some program currently running under NASESI, such as NASENI's Nanoparticle Production Workshop and Training, NASENI's Nanotechnology Visiting Researchers Scheme and NASENI's Nanotechnology Research Grant [5]. All this is to ensure effective implementation of nanotechnology in Nigeria.

The research work carried out by Yu-Ri, Eun, Sung, Hyo, Seong, Sang, Young, Jae, Myoung, Ja and Meyoung-Kon [6], in South Korea on Comparative analysis of nanotechnology awareness in consumers and experts reveals that there is need for relevant education in nanotechnology and Nano-materials among the consumers while the expert has some awareness. The survey work by Sheetz, Vidal and Pearson [7], on Nanotechnology: Awareness and societal concerns, the results showed that only 17% of the respondents were able to identify what nanotechnology is, with 76% of the respondents being men. There is the need to increase public awareness of this new field to avoid backlash. Batta et al. [8] emphasized that the level of awareness of Nano- science and technology in developed world is far better, while it is very low or lower in the developing world. Also et al. [9], emphasized, that in the developed countries, there has been more public campaigns on nanotechnology, on its risk, benefit and trust, and there is enthusiastic from public opinion. The awareness of a thing could lead to a better perception.

Perception is very important since it has to do with the conscious understanding of something by an individual. The acuteness of one's vision towards a phenomenon describes perception. A high perception produces a wide range of interest and a greater influence. Nanotechnology can be said to be better perceived by the Nigerian government judging from the interest and investment of the various agencies and programs of the Nigerian government. In a research work, Suono [10] carried out on perception approach on viewing concepts as gestalts in physics teachers' education, reveals that good perception precedes conceptualization and is an antidote to rote learning. This goes to support the view that a good perception is a key to a better understanding of a fact.

According to Hub [11] Nanotechnology can be applied in the following areas:

1. Energy: Its ability to improve fuel cells to increase the life cycle and also to reduce the cost of a catalyst.
2. Medicine – it is applicable in medicine to improve the drug delivery to diseased cells including steroids which prevent artery blockage.
3. Industry – it is applicable to manufacture faster and safer cars, same in aerospace. It is also of benefit in the development of Nano fibres since the clothes made from Nano fibres are stain-repellent that are washed at low temperatures. Also applicable in communication and electronics, by reducing the weight and power consumption of electronic devices and it also increasing the speed of data processing and in addition, in the production of consumer goods such as anti-reflective sunglasses, ceramics and modern cosmetics.

1.1 Statement of the Problem

The development of any nation depends wholly on the level of its technological advancement and the exposition of her citizens to the use of

modern technology. Modern technology such as Nanotechnology is of importance to the society. The knowledge and application of Nanotechnology can be achieved through secondary school science instruction, more especially as naturally occurring nanomaterial existed in ashes and smoke which man is familiar with, but ignorant of it as nanomaterial. The awareness of nanotechnology in improving health, sources of nanoparticles, the use of Nano scale, and presence of Nano materials in our food and our environment is very vital. Nanotechnology is related to Physics Education, but how much of Nanotechnology is being taught in the secondary schools by the teachers, are the Physics teachers aware of this technology? Therefore, the study investigates the awareness level and the perception of secondary school Physics teachers toward Nanotechnology.

1.2 Aim and Objectives of the Study

The aim of this study is to investigate the awareness level and the perception of secondary school Physics teachers toward Nanotechnology.

The following objectives guided the study:

1. Determine the awareness level of nanotechnology among senior secondary school Physics teachers in Rivers State.
2. Investigate the perception of nanotechnology among Physics teachers in the secondary schools in Rivers State.

1.3 Research Questions

1. What is the level of awareness of nanotechnology among senior secondary school Physics teachers in Rivers State?
2. What is the perception of secondary school Physics teachers towards nano-technology?

1.4 Hypotheses

The following null hypotheses guided the study:

H_{01}: There is no significant difference between the nanotechnology awareness level among male and female senior secondary school Physics teachers.

H_{02}: There is no significant difference between the perception of male and female secondary school physics teachers towards nanotechnology.

2. METHODOLOGY

The study is a descriptive survey. Purposive sampling was used to get the sample. Physics teachers only were used for the study, since they teach and are conversant with the secondary school physics content. The population of the study was 43 Physics teachers comprising of 25 male and 18 female secondary school Physics teachers, from 12 co-educational public secondary schools in Port Harcourt Metropolis of Rivers State. (Rivers State Secondary Schools Board). The population becomes the sample size since all the physics teachers were used for the study. The instrument developed has 10-item self-structured questionnaire for teachers tagged ‘‘Nanotechnology Questionnaire on Awareness and Perception for Teachers (NQAPT).’’ The face and content validity of the instrument were scrutinized by experts of Physics Education. The reliability of the instrument is 0.86 obtained using Cronbach Alpha statistical techniques. The researcher administered the questionnaire with the help of 2 research assistants. The responses were structured, using the modified Likert- type rating scale as follows: Strongly Agreed (SA=4), Agreed (A=3), Disagree (D=2) and Strongly Disagree (SD=1). Very High Level (VHL=4), High Level (HL=3), Low Level (LL=2), Very Low Level (VLL=1). The criterion mean is gotten from the weighted mean responses of 2.5 (Criterion mean). The criterion mean was used in providing answers to the research questions. The item that received a response at 2.5 and above was considered to be accepted, while any item that received a mean response below 2.5 was considered to be rejected. The hypotheses were tested using t –test at 0.05 level of significance.

3. RESULTS AND DISCUSSION

Research questions 1: What is the level of awareness of nanotechnology among senior secondary school physics teachers?

The results on the Table 1 shows the calculated mean scores of some items which are 2.30, 2.09, 1.60, 2.16, and 1.58 with their respective standard deviations (SD) as 37.03, 9.57, 11.41, 25.14 and 15.68 which were not accepted because their mean scores fell below the criterion mean of 2.50. The grand mean of 2.38 is lower than the criterion mean of 2.50; hence there is a low level of awareness of nanotechnology among senior secondary school teachers.

Table 1. Level of awareness of secondary school Physics teachers on Nanotechnology

S/N	Questionnaire	VHL	HL	LL	VLL	Total	Mean $\overline{X}$	SD	Remarks
1	The concept of nanotechnology is new to me	70(57.85)	20(16.67)	15(12.40)	16(13.22)	121	2.81	26.59	Accepted
2	The concept of nanotechnology is not new to me	80(88.89)	10(10.10)	1(1.01)	8(8.08)	99	2.30	37.03	Rejected
3	Nanotechnology can be taught alongside secondary school physics curriculum	10(11.11)	20(2.22)	30(33.33)	30(33.33)	90	2.09	9.57	Rejected
4	Nanotechnology cannot be taught alongside secondary school physics curriculum	60(50.42)	20(16.81)	15(12.61)	24(20.17)	119	2.77	20.50	Accepted
5	More research work still needs to be carried out about nanotechnology	80(63.50)	2015.87)	15(11.91)	11(8.73)	126	2.93	32.54	Accepted
6	Nanotechnology is taught in secondary schools	15(21.74)	10(14.49)	10(14.49)	34(49.28)	69	1.60	11.41	Rejected
7	Nanotechnology is not taught in secondary schools	70(55.12)	10(7.87)	12(9.45)	20(15.75)	112	2.60	28.33	Accepted
8	I am familiar with the concept of nanotechnology	60(64.52)	15(16.13)	3(3.23)	15(16.13)	93	2.16	25.14	Rejected
9	I am familiar with the concept of nanotechnology	80(62.99)	12(9.45)	15(11.81)	20(15.74)	127	2.95	32.34	Accepted
10	I have little knowledge about nanotechnology	40(58.82)	13(19.11)	10(14.71)	5(7.35)	68	1.58	15.68	Rejected
Total Mean							23.79		
Grand Mean							2.38		

Very High Level (VHL)=4, High Level(HL)=3, Low Level(LL) =2, Very Low Level (VLL)=1

Table 2. Perception of secondary school Physics teachers towards Nanotechnology

S/N	Questionnaire	SA	A	D	SD	Total	Mean	SD	Remarks
1	There is Physics background in nanotechnology.	40(24.85)	40(24.85)	50(31.06)	31(19.26)	161	3.74	7.76	Accepted
2	The knowledge of nanotechnology could be applied to measure much smaller objects.	40(27.40)	30(20.55)	50(34.25)	26(17.81)	146	3.40	10.75	Accepted
3	Nanotechnology should be taught in secondary schools.	45(29.80)	50(33.11)	30(19.87)	26(17.22)	151	3.51	11.56	Accepted
4	Nanotechnology should not be taught in secondary schools.	60(37.50)	45(28.13)	30(18.75)	25(15.63)	160	3.72	15.81	Accepted
5	I like the concept of nanotechnology.	70(47.30)	43(29.05)	20(13.51)	15(10.13)	148	3.44	25.15	Accepted
6	I do not like the concept of nanotechnology.	10(11.76)	25(29.41)	8(9.41)	42(49.41)	85	1.98	15.78	Rejected
7	Nanotechnology is not difficult to understand since it is physics oriented.	70(72.92)	3(3.13)	10(10.42)	13(13.54)	96	2.23	30.95	Rejected
8	Nanotechnology is very difficult to understand since it is physics oriented.	20(15.50)	40(31.00)	30(23.26)	39(30.23)	129	3.00	9.32	Accepted
9	Nanotechnology should be taught in higher institutions.	80(57.14)	20(14.28)	10(7.14)	30(21.43)	140	3.26	31.09	Accepted
10	The laboratories in the secondary schools are not well equipped to teach nanotechnology.	70(46.67)	35(23.33)	25(16.67)	20(13.33)	150	3.49	22.55	Accepted
Total Mean							31.77		
Grand mean:							3.18		

Table 3. Responses of male and female secondary school physics teachers on the awareness level of Nanotechnology

Male Physics teachers							Female Physics teachers						
VHL	HL	LL	VLL	Total	Male mean	SD	VHL	HL	LL	VLL	Total	Female mean	SD
40	40	50	35	165	6.60	6.29	40	20	50	10	120	6.67	18.26
40	30	50	25	145	5.80	11.09	40	30	30	15	115	6.39	10.31
45	50	30	68	193	7.72	15.67	40	42	20	10	112	6.22	15.58
60	45	30	25	160	6.40	15.81	50	15	10	20	95	5.28	17.97
70	43	35	15	163	6.52	22.78	70	20	10	10	110	6.11	28.72
10	25	45	42	122	4.88	16.26	10	15	8	32	65	3.61	10.90
70	30	25	13	138	5.52	24.72	70	3	10	10	93	5.17	31.34
25	25	30	39	119	4.76	6.60	20	20	30	29	99	5.50	5.50
10	45	10	30	95	3.80	17.02	80	10	10	5	105	5.83	35.91
70	15	25	20	130	5.20	25.33	70	8	25	20	123	6.83	27.12
				Mean	5.72						Mean	5.76	
				Var	1.28							0.89	

Very High Level (VHL)=4, High Level(HL)=3, Low Level(LL) =2, Very Low Level (VLL)=1

Table 4. t- test on responses of male and female secondary school physics teachers on the awareness level of Nanotechnology

Gender	N	$\bar{X}$	SD	Df	P-Value	t cal	t crit	Decision
Male	25	5.72	1.131	41	0.931	0.088	2.101	Not Significant
Female	18	5.76	0.94					

Table 5. Perception of male and female physics teachers on Nanotechnology

Male Physics teachers							Female Physics teachers						
SA	A	D	SD	Total	Male Mean	SD	SA	A	D	SD	TOTAL	Female Mean	SD
70	45	50	30	195	7.80	16.52	70	20	15	16	121	6.72	26.59
80	10	60	8	158	6.32	36.16	80	10	1	8	99	5.50	37.03
10	20	45	30	105	4.20	14.93	10	20	30	30	90	5.00	9.57
60	20	30	24	134	5.36	18.14	60	20	15	12	107	5.94	22.41
80	20	45	11	156	6.24	30.89	50	20	15	23	108	6.00	15.68
15	10	10	30	65	2.60	9.46	10	10	10	20	50	2.78	5.00
70	10	12	20	112	4.48	28.33	50	10	12	10	82	4.56	19.69
60	5	3	10	78	3.12	27.16	60	15	3	5	83	4.61	26.69
80	8	15	8	111	4.44	34.99	50	12	15	10	87	4.83	18.95
40	13	10	5	68	2.72	15.68	20	13	10	5	48	1.12	6.27
				Mean	4.73						Mean	4.71	
				Var	2.91							2.74	

Table 6. t-test on the perception of male and female secondary school Physics teachers on Nanotechnology

Gender	N	$\bar{X}$	SD	Df	P-Value	t-cal	t-crit	Decision
Male	25	4.73	1.71	41	0.977	0.029	2.101	Not significant
Female	18	4.71	1.65					

Research questions 2: What is the perception of secondary school Physics teachers towards nanotechnology.

The result in Table 2 shows that item 6 and 7 with mean scores of 1.98 and 2.23 with corresponding standard deviation of 15.78 and 30.95 were not accepted because they fell below the criterion mean of 2.50. The grand mean is 3.18 and is higher than the criterion mean of 2.50. This shows that the perception of the teachers towards nanotechnology is positive.

Hypotheses:

H_{O1}: There is no significant difference between the nanotechnology awareness level among male and female senior secondary school physics teachers.

The result of the t –test in Table 4, shows that the calculated value of 0.088 is less than the critical t-value of 2.101 at 0.05 level of significance with a degree of freedom of 41.Therefore the hypothesis is retained. That is, there is no significant difference between the nanotechnology awareness level among male and female senior secondary school Physics teachers.

H_{O2}: There is no significant difference between the perception of male and female secondary school Physics teachers towards nanotechnology.

The result of the t-test in Table 6 shows that the calculated value of 0.029 is less than the critical t-value of 2.101 at 0.05 level of significance with a degree of freedom of 41. Therefore the hypothesis is retained. That is, there is no significant difference between the perception of male and female secondary school Physics teachers towards nanotechnology.

On the level of awareness of nanotechnology by Physics teachers in the secondary schools, the result from Table 3, shows the value of the grand mean of 2.38 is less than the criterion mean of 2.5, this means the awareness level is low. The result of the t –test shows that the calculated t-value of 0.088 is less than the critical t-value of 2.101 at 0.05 level of significance showing that there is no significant difference between the nanotechnology awareness level among male and female senior secondary school Physics teachers. This support the research findings of Yu-Ri, Eun, Sung, Hyo, Seong, Sang, Young, Jae, Myoung, Ja, and Meyoung-Kon [6], in South Korea on the Comparative analysis of nanotechnology awareness in consumers and experts. Their findings revealed that there is the need for relevant education in nanotechnology and nano-materials among the consumers while the expert has some awareness. This also agrees with the work of Sheetz,Vidal and Pearson [7], on Nanotechnology: Awareness and societal concerns, that awareness is low with only 17% of the respondents could identify what nanotechnology is. The low level awareness of teachers means that there is need to create more awareness on nanotechnology in secondary school.

The findings on the perception of nanotechnology by Physics teachers revealed the perception of the teachers towards nanotechnology is positive. $\bar{X}: 3.18 > 2.50$. This reveals good sense of acceptance by the teachers and a great sense of readiness on nanotechnology. However, the result of the t –test shows that the calculated value of 0.029 is less than the critical t-value of 2.101 at 0.05 level of significance and degree of freedom of 41, which means there is no significant difference between the perception of male and female secondary school Physics teachers towards nanotechnology. This study is in line with the research work by Suono [10] on perception approach on viewing concepts as gestals in Physics teachers' education; Good perception precedes conceptualization and is an antidote to rote learning. This goes to support the view that a good perception is a key to a better understanding of a fact.

4. CONCLUSION AND RECOMMENDATION

This paper presented the awareness level and perception of secondary school Physics teachers towards nanotechnology. It was discovered that the awareness level of Nanotechnology among teacher was low and their perception towards nanotechnology was positive. No significant differences exist between the awareness level and perception of the concept of Nanotechnology among the male and female senior secondary school Physics teachers in Rivers State. This study was carried out by secondary school teachers. Therefore, the same study can be done considering tertiary institution such as universities and polytechnic lecturers. Based on the findings, it is recommended that:

1. There should be teachers' workshop and seminars in order to create more awareness about nanotechnology in secondary schools.
2. There should be more enlightenment on the benefits of nanotechnology to the society.
3. There should be pre-service and in service training workshops on nanotechnology for teachers in all aspect of education.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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