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Integrating Nanoscience/Nanotechnology Advances in ICT and Chemistry into the Secondary School Curriculum in Rivers State

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Abstract
Nanoscience and nanotechnology are fundamental, crucial and basic ingredients in today's contemporary world where considerations are accorded to comfortability. Everyone wants to do something with maximum ease. For instance, the idea of carrying large goods in the form of medicines, papers, money, etc is conquered as these things are being handled in a miniaturized form. The rapid growth and societal significance of Nanoscience and Nanotechnology (NST) calls for an urgent need for addressing these topics in school curricula. Nano-scale material which helps in producing new materials that can be used in the fields of medicine, industry, engineering, agriculture, drugs, communications, defense, space, among others. This study highlights the ground works and the building blocks of these concepts in responding to those needs in the Secondary School Curriculum. The research design is survey of computer and chemistry teachers' awareness of nanoscience and nanotechnology concepts in secondary schools, and computer and chemistry teachers' opinions of integrating nanosience and nanotechnology concepts into the secondary school curriculum. A sample of 38 teachers (20 Computer and 18 Chemistry) in 20 secondary schools in Ahoada West and Abua/Odual was purposively selected and utilized for the study. One instrument developed by the researchers was used for this study. The instrument has two clusters- A and B. Cluster A covers Computer and Chemistry Teachers' Awareness of Nanoscience and Nanotechnology Concepts in Secondary Schools (CCTANNCSS). The second, cluster B covers Computer and Chemistry Teachers' Opinions of Integrating Nanoscience and Nanotechnology Concepts into the Secondary School Curriculum (CCTOINNCSSC). The instrument was validated by two experts in computer and chemistry. Cronbach Alpha was used to calculate the reliability index of the instrument. The reliability coefficients of 0.78 and 0.81 were gotten respectively for cluster A and B. It was concluded that computer and chemistry teachers have low awareness level since the mean value of 2.03 is below the 2.5 benchmark of high level. It is therefore recommended, among others, that at secondary school level greater attention needs to be given to pedagogical information on nanoscience and nanotechnology.
Keywords: Nanoscience, Nanotechnology concepts, Integrating, pedagogic information, ICT and Chemistry curriculum.
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Introduction

No doubt as noted NST are advancing rapidly, and increasingly gaining significant societal and economic prospects which are attached to the various emerging fields. However, infusion of education in NST at different levels has been called for throughout the whole world (Ball, Patil & Soni, 2019; Elegbede & Lateef, 2019a; Elegbede & Lateef, 2019b). These demands have been made from a variety of viewpoints (Antti, 2011; Lateef, 2020), related to the general challenges of education in science, technology, engineering and mathematics (STEM). There is an increasing concern that in the coming years the world will be running short of scientists and engineers with specialization in nanoscale issues (Engeman, Baumgartner, Carr, Fish, Meyerhof, Satterfield, Holden & Harthorn, 2013; European Commission, 2010; Ministry of Education, 2005). The prospects of NST education has also been motivated as nanotechnology involving both benefits and risks regarding environment and health, as well as a few other ethical concerns (Moor & Weckert, 2004). Nanoscience and nanotechnology are fundamental and basic ingredients in today's modern world where considerations are accorded to comfortability (Antti, 2011; Ezekiel, 2020). Everyone wants to do something with maximum ease. For instance, the idea of carrying large goods in the form of medicines, papers, money, etc is conquered as these things are being handled in a miniaturized form. That is to say, a multinational oil company or even a country as a whole can housed all of its information on their entire existing organograms in a nanochip that is as tiny as 14 nanometres. This really indicates that a multinational company or a country as the case may be, could be pocketed and walked around in the street. Conceptually, a nanochip is an integrated circuit (IC) that is so diminutive in physical terms, that discrete particles of matter play foremost roles.

Information is the knowledge gained or given (Omiko, 2013). Alumode (2013) asserted that to have knowledge is to be empowered. According to Nnwadi, this is the reason great philosophers compare knowledge with power. The act of conveying information or knowledge from one individual to another is communication. Whereas, technology is a method or technique of doing things that commonly will lead to practical applications (Zudonu, Nnaobi & Ezegbirika, 2011). In a clear term, this implies that technology is the application of knowledge derived from science to meet societal demands (Zudonu, Nnaobi & Ezegbirika, 2011). Information and Communication Technology (ICT) is a technology that sustains activities involving information. However, in education the cardinal activities involved include knowledge, experience and products. In fact, the application of ICT in educational activities cannot be overemphasized since we are in the computer era or age. Nworgu (2007) opined that computer is the hub of all ICT-application. This is so because, in virtually all the applications, computer is interfaced with various devices in processing and communication functions. In this study, ICT will be used interchangeably with Computer. The reason is that, in secondary school the concept ICT is narrowed down to computer.

Chemistry is the science that embraces the properties, composition, and structure of matter, the changes in structure and composition that matter undergoes, and the accompanying energy changes (Zudonu, Nnaobi and Ezegbirika, 2014). It is therefore the bases for the understanding of the constitution of both animate and inanimate things around us. The usefulness of chemistry affects all dimensions of human spheres such as agriculture, housing, medicine, fuel, textile, cosmetics, kitchen, toiletries, plastics, paper, communication and industries. Since nanomaterials subsist virtually in all the areas mentioned, it is therefore pertinent for its inclusion into the secondary school curriculum.

The concept of awareness of ICT and Chemistry teachers on nanoscience and nanotechnology has received generally scanty attention. The reason could be that since the concepts are relatively novel. Previous researchers like Naidu, Sawhney & Li (2008), Busnaina, Mead, Isaacs & Somu (2013), Diallo, Froma & Jhin (2013) and Ezema, Ogobe and Omah (2014), Elegbede & Lateef (2020) who indicated that nanotechnology is still a young field under extensive development and many science teachers in high school may not have gotten adequate awareness on them. However, Drexler (2013) asserted that the nanotechnology field is relatively new but has the potential to help increase the sustainability of human system. The finding of Drexler (2013) also corroborates the result of this study. Nonetheless, some interfaces have been considered and studied, but many of them were limited to economic, environmental, health, engineering etc. As a result of this, one could say that ICT and Chemistry teachers in secondary schools or high schools have been mentioned sparingly linking to nanoscience and nanotechnology, which are nanomaterials in general. In view of this, it is apt that a clarion calls for the inclusion of nanoscience and nanotechnology into the secondary school curriculum is heard at this time.

The Research Problem

A pragmatic step in solving a problem is defining and identifying such problem. Analysing the needs and prospects of including a new field into the curriculum requires defining and understanding the concepts from the respondents. The young and navel field of nanoscience and nanotechnology that have extremely scanty forms of pedagogic information made known to science teachers in workshops, seminars, symposia and conferences could rarely gain massive acceptance in the educational system. It may be considered that teachers are not familiar enough with the new fields of NST and the study seeks to verify the veracity of such claims. The question that remains is whether computer and chemistry teachers are aware of the concepts nanoscience and nanotechnology? What opinions do computer and chemistry teachers have about the inclusion of nanoscience and nanotechnology education in secondary school curriculum? These were the problems which the study addressed.

Conceptual Framework

The broad concept of nanoscience and nanotechnology (NST) lies within the framework of atoms and molecules in chemistry which by design, the dimension and tolerance in the range of 0.1nm to 100nm plays a critical role. Therefore atoms and molecules seem to be the paradigm of the vision of NST, but individual atoms and molecules in the range are not attributing to NST. More so, Information and Communication Technology (ICT) and nanotechnology are the top players at the beginning of the 21st century, they seek to improve environment efficiency and effectiveness in terms of connecting communities, global competiveness on economic development, climate change etc. A basic challenging factor that the ICT and chemistry sectors face today is that of hardware constraint, hardware being pushed to its physical limits. The norms or conventional way to reduce product size, increase functionality and enhance or boost fast computing capabilities and getting more difficult and more expensive as time passes. The good news is that both disciplines are benefiting from NT advances in the area of smart sensors, logic elements, nanotubes, computer chips, memory storage, device, quantum computing etc.

Nanotechnology is growing and seen as having great potential to bring benefit to many areas of research. Therefore, its application and inclusion into the secondary school curriculum cannot be overemphasized. So far,

industrial applications with relatively small number of application of nanotechnologies that have made it through the industries represent evolutionary rather than revolutionary advances. Recent applications are mainly in the areas of determining the properties of materials, the production of chemicals, precision manufacturing and computing. There is an active lingering hope that in a short time nanotechnology will bring about more efficient approaches to many manufacturing areas. This would occasion the needed capacity to produce a host of multifunctional materials in a cost-effective manner with reduced resources waste.

The term "nanotechnology" by definition encompasses of such a wide range of tools, techniques and potential applications hence a better or more appropriate way of reference is "nanotechnologies". As noted by "the royal Society & the royal Academy of Engineering in 2004. Nanotechnologies are the design, characterisation, production and application of structures, devices and systems by controlling shape and size at nanometre scale(<100nm) in one dimension.

One nanometre (nm) is equal to one-billionth of a metre, 10^{-9}m. A human hair is approximately 80,000nm wide, a red blood cell approximately 700nm wide. The prefix "nano" is drawn from the Greek word for dwarf. The size range that capture so much interest is between 100nm down to the atomic level (approximately 0.2nm) at this range especially the lower range the properties of materials can vary (enhance) from those at larger scale.

ImpactofNanoscience/Nanotechnology in ICT and Chemistry

At both scale, the nanometre materials can be richly enhanced, properties compared with some materials at a large size, the behaviours include an increased relative surface area and the dominance of quantum effect. The relative increase in surface (per unit mass) will result in corresponding increase in chemical reactivity, hence as catalysts to improve the efficiency of fuel cells and batteries. The reduction of matter to tens of nanometres or less at this point of quantum effects can begin to play a tremendous role, changing material's optical, magnetic or electrical properties. At the larger end of the nanometric scale, surface tension or "stickiness" are important which indeed affect physical and chemical properties (liquid or gaseous environment Brownian motion). ICT sector is experiencing rapid growth as work and social activities are transformed by new and varied technology. This has required computers to become faster, enabled by the production of smaller transistors through nanoscience. Decreasing the size of the transistors allows more on the integrated circuit hence increasing the performance of the computer system. By using properties of nanomaterials to perform calculation, future computers may not need to depend on traditional si-base technology rather single nanowires or quantum dots could be replaced.

Purpose of the Study

The main purpose of this study was to investigate the possibility of integrating nanpscience and nanotechnology concepts into the secondary school curriculum. Specifically the study sought to,

1.determine the extent of awareness of computer and chemistry teachers on nanoscience and nanotechnology.

2.examine computer and chemistry teachers' opinions on the integration of nanoscience and nanotechnology into the secondary school curriculum.

Research Questions

1. To what extent do computer and chemistry teachers have awareness on nanoscience and nanotechnology in secondary schools?

2. What are computer and chemistry teachers' opinions on the integration of nanoscience and nanotechnology into the secondary school curriculum?

Method

The research design is survey of computer and chemistry teachers' awareness of nanoscience and nanotechnology concepts in secondary schools and computer and chemistry teachers' opinions of integrating nanosience and nanotechnology concepts into the secondary school curriculum. All the computer and chemistry teachers in Abua/Odual and Ahoada West Local Government Areas formed the population of the study. A sample of 38 teachers (20 Computer and 18 Chemistry) in 20 secondary schools in Abua/Odual and Ahoada West was purposively selected and utilized for the study. It was purposive because every approved school that has existed for three years qualified to be included. On this premise, all the schools selected for this study met the criterion. One instrument developed by the researchers was used for this study. The instrument has two clusters-A and B. Cluster A covers Computer and Chemistry Teachers' Awareness of Nanoscience and Nanotechnology Concepts in Secondary Schools (CCTANNCSS). The second, cluster B covers Computer and Chemistry Teachers' Opinions of Integrating Nanoscience and Nanotechnology Concepts into the Secondary School Curriculum (CCTOINNCSSC). CCTANNSSC is a 12-item structured questionnaire. Also, CCTOINNCSSC is a 12-item structured questionnaire. The instrument was validated by two experts in computer and chemistry. Cronbach Alpha was used to calculate the reliability index of the instrument. Cronbach Alpha

was used because the items were non-dichotomously scored. In the same vein, the reliability coefficients of 0.78 and 0.81 were gotten respectively for cluster A and B. With the help of a research assistant, copies of the questionnaires were distributed and collected on the sport. In the first instrument, the respondents were asked to indicate their level of agreement with items in the questionnaire for cluster A by ticking one of the options and values assigned as follows, High extent (HE)=4, Moderate extent (ME)=3, Low extent (LE)=2, and Very low extent (VLE)=1. Mean scores were used to answer the research questions. And for cluster B, the respondents were asked to indicate their level of agreement with items in the questionnaire for cluster B by ticking one of the options and values assigned as follows, Strongly Agree (SA)=4, Agree (A)=3, Disagree (D)=2, and Strongly Disagree (SD)=1.

Results

Research Question 1: To what extent do computer and chemistry teachers have awareness on nanoscience and nanotechnology in secondary schools?

Table 1: Mean and standard deviation ratings of extent computer and chemistry teachers have awareness on nanoscience and nanotechnology in secondary schools

S/N	Items	Computer teachers (N=20)			Chemistry Teachers (N=18)			Overall (N=38)		
		X	SD	Rem.	X	SD	Rem.	X	SD	Rem.
1.	Molecular modelling requires nanoscience and nanotechnology	2.35	0.93	LE	2.22	0.73	LE	2.29	0.84	LE
2.	Measurement requires nanoscience and nanotechnology	2.35	1.09	LE	2.17	0.92	LE	2.26	1.00	LE
3.	In the area of drugs, nanoscience and nanotechnology are crucial	1.90	1.12	LE	1.83	0.99	LE	1.87	1.04	LE
4.	Nanoscience and nanotechnology are applied in area of electrochemical sensors	2.10	1.07	LE	1.78	0.88	LE	1.95	0.98	LE
5.	Nanoscience and nanotechnology are massively involved in forensic activities	2.30	1.08	LE	2.39	1.04	LE	2.34	1.05	LE
6.	Neuroscience involves nanoscience and nanotechnology	2.05	1.05	LE	1.78	1.06	LE	1.92	1.05	LE
7.	Solar energy requires the use of Nanoscience and nanotechnology	2.25	0.97	LE	2.28	0.99	LE	2.26	0.95	LE
8.	Newest electronics requires Nanoscience and nanotechnology	2.10	0.91	LE	2.06	0.64	LE	2.08	0.78	LE
	Overall	**2.18**	**0.51**	**LE**	**2.06**	**0.49**	**LE**	**2.12**	**0.34**	**LE**

NB: LE=Low Extent; Rem.= Remark; SD= standard deviation, X=mean, N= Number

Table 1 revealed that the awareness level of the respondents is at low extent. This is because their mean ratings were below 2.5 benchmark set by the researchers. This suggests that computer and chemistry teachers have low awareness on nanoscience and nanotechnology.

Research question 2: What are computer and chemistry teachers' opinions on the integration of nanoscience and nanotechnology into the secondary school curriculum?

Table 1: Mean and standard deviation ratings of opinions of computer and chemistry teachers on the integration of nanoscience and nanotechnology into the secondary school curriculum

S/N	Items	Computer teachers (N=20)			Chemistry Teachers (N=18)			Overall (N=38)		
		X	SD	Rem.	X	SD	Rem.	X	SD	Rem.
1.	I do attend educational public lectures on nanoscience and nanotechnology	2.95	0.99	A.	3.06	0.99	A	3.01	0.99	A
2.	I do attend conferences on nanoscience and nanotechnology	1.90	0.97	D	1.61	0.85	D	1.76	0.91	D
3.	I do attend seminars on nanoscience and nanotechnology	2.10	0.91	D	2.33	1.03	D	2.21	0.96	D
4.	I do attend workshops on nanoscience and nanotechnology	2.10	0.91	D	2.06	0.64	D	2.08	0.78	D
5.	I browse the internet for educational information such as nanoscience and nanotechnology	2.20	0.95	D	2.44	1.04	D	2.32	0.99	D
6.	I buy journals to be abreast with recent educational information in my area	2.00	0.86	D	2.06	0.64	D	2.03	0.75	D
7.	My school buy journals for placement in the library	2.30	1.08	D	1.89	0.68	D	2.11	0.92	D
8.	I visit university libraries for research materials in my area	1.60	.94	D	1.56	0.62	D	1.58	0.79	D
9.	When researchers engage me in research work, they communicate the result to me	2.20	.89	D	2.22	0.81	D	2.21	0.84	D
10.	I organize debates to get information on nanoscience and nanotechnology	2.05	.99	D	1.94	0.73	D	2.00	0.87	D
11.	Nanoscience and nanotechnology are basics for computer and chemistry therefore should be included in secondary school curriculum	2.35	1.09	D	2.11	0.76	D	2.24	0.94	D
12.	I strongly recommend the inclusion of nanoscience and nanotechnology in the science curricular because I have acquired knowledge from conferences and workshops	2.20	1.01	D	1.94	0.80	D	2.08	0.91	D
	Overall	**2.16**	**0.50**	**D**	**2.10**	**0.34**	**D**	**2.14**	**0.45**	**D**

NB: D= Disagree; A= Agree; Rem.= Remark; SD= standard deviation; X=mean; N= Number

Table 2 indicated that the respondents disagreed the inclusion of nanoscience and nanotechnology in the secondary school computer and chemistry curriculum except in item 1. This is because their mean ratings were below 2.5 benchmark set by the researchers. This suggests that computer and chemistry teachers have negative opinions towards the integration of nanoscience and nanotechnology in the secondary school computer and chemistry curriculum. This could be attributed to their low extent of awareness on nanoscience and technology.

Discussion of the Findings

Table 1 revealed that the awareness level of the respondents is at low extent. This is because their mean ratings were below 2.5 benchmark set by the researchers. This suggests that computer and chemistry teachers have low awareness on nanoscience and nanotechnology. The result of this study supports the views of previous

researchers like Naidu et al (2008), Busnaina et al (2013) and Diallo et al (2013), they indicated that nanotechnology is still a young field under extensive development, though, many high school biology, computer, chemistry and physics, even in mathematics teachers may not have gotten adequate awareness on. However, Drexler (2013) asserted that the nanotechnology field is relatively new but has the potential to help increase the sustainability of human system. The finding of Drexler (2013) also corroborates the result of this study.

Table 2 indicated that the respondents disagreed on the inclusion of nanoscience and nanotechnology in the secondary school computer and chemistry curriculum except in item 1. This is because their mean ratings were below 2.5 benchmark set by the researchers. This suggests that computer and chemistry teachers have negative opinions towards the integration of nanoscience and nanotechnology in the secondary school computer and chemistry curriculum. This could be attributed to their low extent of awareness on nanoscience and technology. The result is in discordance with the findings of researchers like Antti (2011), Ban & Kocijancic (2011) and Mutambuki (2014), since the results of their study revealed that nanoscience and nanotechnology concepts should be included in high school curriculum.

Conclusion

From the result obtained in the study integrating nanoscience/nanotechnology advances in ICT and chemistry into the secondary school curriculum in Rivers State, it was found that;

(1) the awareness level of computer and chemistry teachers in secondary school is at low extent.

(2) computer and chemistry teachers have negative opinions on the inclusion of nanoscience and nanotechnology concepts into the secondary school curriculum.

Recommendations

Based on the findings of this study and their implications, the following recommendations were made;

(1) that at secondary school level greater attention needs to be given to pedagogical information on nanoscience and nanotechnology. This can be achieved if the State Government buys computers and provides electricity for all Government owned secondary schools in the State. Through this process, the dissemination of pedagogical information could be enhanced.

(2) that the state government should seize all opportunities available to organize and sponsor secondary school science teachers to attend workshops, seminars, symposia and conferences on nanoscience and nanotechnology. This activity, if felt, has the capacity to raise the extent of awareness on nanoscience and nanotechnology to a high extent. It could as well alter the negative opinions of teachers on the inclusion of nanoscience and nanotechnology concepts into the secondary school curriculum to a positive one.

Suggestions for further study:

- The study can be replicated using different research design.
- The study could be carried out in other science subject (s) other than the ones used.
- The study should be conducted in the pure and applied sciences and engineering as the society has a lot to benefit from it.

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