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Developing Students' Divergent Thinking Paradigm Through ICT Tools Application In Teaching Science, Technology And Mathematics (STM)

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ABSTRACT

The paper was focused to examine Science, Technology and Mathematics (STM) teachers' skills acquisition and application of ICT tools in developing students' divergent thinking paradigm. A descriptive survey research design and stratified random sampling technique, a sample size of 180 STM teachers were used in Port Harcourt Local Government Area of Rivers State, Nigeria. Data collecting instrument was a questionnaire titled "Information Communication Technology Skills and Application in Science, Technology and Mathematics" (ICT-SASTM) having a reliability coefficient of 0.78 was used to elicit response from the respondent. Data obtained were analyzed using the mean, standard deviation and Analysis of Variance (ANOVA) through the application of SPSS software. Based on the analyzed data, the following findings were made; that STM teachers do not acquire the basic ICT skills such as Microsoft power point skills, Microsoft excel and internet skills, also STM teachers do not adequately apply ICT tools in teaching STM concepts. In light of the findings of the study, the following are recommended; STM teachers should avail themselves training and retraining on the usage of innovative ICT tools in teaching STM concepts so as to develop their students' divergent thinking paradigm for sustainable and reliant citizenry. Government and school owner should assist in providing avenues for training of the teachers on the use of ICT tools during classroom interactions. ICT facilities should be made available in schools for STM teachers' usage.
Key words: Divergent thinking, ICT tools, Application, Science, Technology and Mathematics.

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INTRODUCTION

Science, Technology and Mathematics (STM) education is an important area of study that plays significant role in national development. It is a driving force for change and provides the platform on which humans derives satisfaction. Okebukola (1996) mentioned that every nation in the 21st century is striving to achieve scientific and technological breakthrough within and outside their environment. Nbina and Needom stated that science provides insight about nature, technology applies scientific knowledge in the transformation of natural things for man's benefit while mathematics is the bond between science and technology by providing the scientific driving capacity for technological accomplishment. One of the most important goals of STM education is the functionality and utilitarian ways of preparing individuals for life in community and reforming the society for relevance, adequacy and competiveness in the world (Egbo, 2011). The above implies that any nation that employs conscious effort to meet up the global challenges should not underestimate the potency of science, technology and mathematics of her citizenry. According to Matzu (2009), it was maintained that STM education is the most crucial instrument for change and positive transformation in any society, whether developed, developing or underdeveloped. Nigeria as a progressive country also in her quest to achieve sustainable scientific and technological growth integrated concepts of STM into her secondary school curriculum. It is in this regard that Abe (2010) stressed that functional STM education is positioned in producing competent and balance students assisting them to attain high level skilled manpower. Morrison cited in Ugwuda and Odo (2014) stated the functions and implications of a learner that have passed through the STM programme as one who is a/an;

(i) **Problem solver:-** able to define questions and problems, design, investigates and gather data, analyze the data, draw conclusions and apply in existing situations and or novel situations
(ii) **Innovators/inventors:-** creatively use science, technology and mathematical principles by applying them in solving complex issues relating to human existence.
(iii) **Self reliant individual:-** be initiative, self motivated, self confident and goal oriented individual considering time and space in accomplishing any tasks.
(iv) **Logical thinker:-** application of rational and logical thought processes of science, technology and mathematics to innovative and invention practice.
(v) **Scientific and technologically literate:-** understanding of scientific principles and their applications in technological process and product

For one to be successful in science and technology, students must develop deep conceptual understanding of the underlying science ideals, ability to apply these ideas and concepts broadly in different contexts and a vision to see their relevance and usefulness in real world applications (Perkins and Wieman, 2008). The significance of the statements of Perkins and Wieman (2008) as further buttress by Adeniran (2008) and Ale (2009) pointed out the benefits STM offers to our nation;

(i) produce citizens that manufacture new materials, machines and tools needed for our industries, road constructions and water dams,
(ii) produce enough food for local and international markets through mechanized agriculture by having good STM abilities to make weather forecast and other agricultural calculations,
(iii) invent new designs such as; discover drugs capable of curing diseases as a medical doctor and pharmacist
(iv) focus on the need for more investment in research and development.

In light of the above, it is obvious that compliance with best practice in STM holds a better future for our nation whereby the learner is inculcated with the ability to synthesize and see new applications, be resourceful and possess creative thinking process. Science, technology and mathematics as a discipline that entails creative thinking process such that students acquire knowledge and readiness in facing the world of work. Two elements of creative thinking are;

1. **Convergent thinking:** It is a thinking process or idea that is directed to solving a given task or problem.
2. **Divergent thinking:** This is an approach that requires and open new avenues for thought or ideas employing different strategies in solving a particular problem or task.

Guiford cited in Uzoechi (2014) classified divergent thinking into three skills such as fluency, flexibility and novelty. Students who have large numbers of ideas and produces significant ideas are referred to be fluent, flexible divergent thinkers are those students that have the ability to generate ideas from different perspective while students that possess thinking skills having unusual but appropriate ideas are classified as novelty divergent thinkers.

It is no gainsaying that the above classifications of divergent thinking skills are essential attributes that every STM students should possess. It is based on this note that the role of the teacher in developing this element of thinking is of great importance. STM teachers' task is not merely the impartation of content knowledge to their students but help them in harnessing their potentials, ensuring originality of ideas and mastery of knowledge getting process based on inbuilt thinking paradigm. Uzoechi (2014) stated that to aid students develop divergent thinking attributes, it is important that there should be a shift from the traditional methods of instruction of teaching STM to innovative format. Glass Lab Press Release (2012) in Okonkwo (2014) explained that learning is changing and so must educational institutions in order to engage learner and ensure are taught the participatory and creative skills that are needed to succeed in the 21st century.

In line with the above, Ugwuda (2009) reiterated that the teaching of STM requires trained teachers with Information Communication Technology (ICT) skills required to enhance students thinking process in STM. Okonkwo (2014) expressed that technological application in teaching could foster creative thinking, generate new ideas, explore complex topics and bring learning to life. UNESCO (2008) launched the ICT Competency Standards for Teachers (ICT-CST) to advance the teaching and learning process based on the idea that educational reforms supports national development through the following ways;

1. by developing technology literate citizens through incorporation of technology skills in the curriculum
2. by developing citizens who can apply knowledge to solve complex, real world problems and add value to society and the economy
3. by developing citizens who can innovate and produce new knowledge.

Birabil and Aderonmu (2014) posited that successful utilization of ICT tools in the teaching and learning process among other things is dependent on how the teachers is acquainted with the process of usage. ICT usage in teaching of STM has the capacity to provide higher interactive potential for both the teacher and students, develop intellectual and creative thinking (Mbata, 2011). Competencies in ICT tools usage by STM teachers is a fundamental requirement that can aid the process of transition of the students from being a passive listeners of STM concepts to one who can think critically and reflect on their learning. Based on this note, this study seeks to investigate STM teachers' application of ICT on students' development of divergent thinking paradigm in the learning of STM in secondary schools in Nigeria.

Purpose of the study

The purpose of this study is to investigate students' development of divergent thinking paradigm through STM teachers' application of ICT. Specifically, the objectives of the study are to:

1. investigate STM teachers' extent of ICT skills acquisition in developing students' divergent thinking paradigm in STM.
2. determine STM teachers' extent of application of ICT tool in teaching STM concepts so as to developing students' divergent thinking paradigm in STM.

Research questions

In an attempt to investigate students' development of divergent thinking paradigm through ICT tools application in teaching of STM, the following research questions were raised;

(1) To what extent STM teachers in terms of male and female acquire ICT skills in teaching of STM concepts so as to develop students' divergent thinking paradigm?

(2) To what extent STM teachers apply ICT tools in teaching of STM concepts so as to develop students' divergent thinking paradigm?

Hypothesis

HO_1: There is no significant difference between science, technology and mathematics teachers acquisition of ICT skills in developing students' divergent thinking paradigm.

HO_2: There is no significant difference between science, technology and mathematics teachers application of ICT tools in developing students' divergent thinking paradigm.

METHODOLOGY

The study employed descriptive survey design. The population of the study consists of all Science (basic science, biology, chemistry and physics) teachers, Technology (basic technology, electrical, building, carpentry, mechanical and technical drawing) teachers and Mathematics teachers in public and private schools in Port Harcourt Local Government Areas of Rivers State. Using a stratified sampling technique, 60 science teachers (30 male and 30 female), 60 technology teachers (30 male and 30 female) and mathematics teacher (30 male and 30 female) were selected for the study.

Instrument for data collection

The instrument for data collection was developed by the researchers and titled "Information Communication Technology Skills and Application in Science, Technology and Mathematics" (ICT-SASTM). The questionnaire consisted of three sections. Section A was developed to gather information on of the teachers such as sex. Section B was design to elicit information on the extent of ICT skills acquired by STM teachers in developing divergent thinking paradigm of their students and Section C focused on STM teachers' application of ICT tools in teaching STM concepts in secondary schools.

The instrument was validated by experts in Curriculum Studies and Educational Technology, University of Port Harcourt for both face and content validity. The instrument was further subjected to a pilot study using the test-retest method of an interval of one week. The purpose of the pilot study was to establish the reliability of the study. A reliability coefficient of 0.78 was obtained using the Pearson Product Moment Correlation (PPMC) formula. The instrument was administered personally by the researchers and 100% retrieval rate was ascertained.

Method of data analysis

The data collected for the study was analyzed according to the research questions and hypotheses. The SPSS software was used to calculate the mean, standard deviation and Analysis of variance (ANOVA) were employed for the study. Criterion mark

RESULTS AND DISCUSSIONS

Research question 1

To what extent STM teachers in terms of male and female acquire ICT skills in teaching of STM concepts so as to develop students' divergent thinking paradigm?

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Table 1: Responses of STM teachers on acquisition of ICT skills.

Skills	Sex	Science		Technology		Mathematics	
		ẋ	SD	ẋ	SD	ẋ	SD
Microsoft Word	M	3.13	0.82	3.01	0.78	2.93	0.78
	F	2.76	0.73	2.50	0.90	2.73	0.83
Microsoft Excel	M	2.40	0.85	2.30	0.92	2.27	1.01
	F	2.13	0.94	2.17	0.79	2.37	0.76
Microsoft power point	M	2.37	0.72	2.03	0.81	2.20	0.85
	F	1.83	0.83	2.07	0.91	2.07	0.83
Internet	M	1.93	0.74	2.13	0.78	2.10	0.88
	F	1.97	0.85	2.07	0.87	2.07	0.94
Total Average mean		**2.32 (ns)**	0.81	**2.29 (ns)**	0.85	**2.34 (ns)**	0.86

ns = not significant
Source: Researchers' fieldwork, 2014.

Table 1 above revealed the responses of science, technology and mathematics teachers' acquisition of ICT skills so as to develop students' divergent thinking paradigm in STM concepts in secondary schools. Four important skills were highlight above and it was indicated that both male and female teachers of science, technology and mathematics had appreciable Microsoft word skills. However, the teachers response indicated that they do not possess Microsoft excel, Microsoft power point and Internet skills. The total average mean of table above indicated that that both male and female teachers of science, technology and mathematics do not possess the fundamental ICT skills necessary to develop students' divergent thinking paradigm with means 2.32, 2.29 and 2.34 respectively.

The findings of this study is in agreement with the findings of Obioma (2006) where it was stated that many STM teachers in Nigeria are not ICT literate, therefore should be trained and retrained in the use of ICT in teaching. The Museum and Library Services (2012) stated that basic computer skills and high level cognitive skills for finding, evaluating, creating and sharing information and fundamental requirement for a digitally inclusive environment. It is on this note that Okonkwo (2014) connotes that teachers should be able to adapt and design relevant learning experiences that engages students in authentic learning through the use of ICT tools and resources possessing adequate ICT competencies.

Research question 2

To what extent STM teachers apply ICT tools in teaching of STM concepts so as to develop students' divergent thinking paradigm?

Table 2: Responses of STM teachers on applications of ICT tools in teaching of STM concepts

S/n	Application of ICT tools	VHE	HE	LE	VLE	ẋ	SD	Decision
1.	Application of multimedia presentation for teaching STM concepts.	17	36	55	72	1.99	0.43	Not significant
2.	Application of spreadsheet to facilitate STM class interactions.	25	31	49	75	2.03	0.76	Not significant
3.	Application of simulations and games in teaching STM concepts.	13	16	37	114	1.60	0.67	Not significant
4.	Applications of moodle for in and out of classroom interactions.	-	8	-	172	1.09	0.63	Not significant
5.	Application of excel in graph plotting and numerical computations.	34	28	69	49	2.26	0.87	Not significant
6.	Application of interactive white board in teaching STM concepts.	6	12	87	75	1.72	0.82	Not significant
7.	Applications of coral draw for 2D and 3D diagrams.	27	26	68	59	2.12	0.95	Not significant
8.	Use of e-book for content referrer.	21	19	87	53	2.04	0.92	Not significant
9.	Application of smartphones for educational purposes	32	28	41	79	1.00	0.78	Not significant
Total average mean		**175**	**204**	**493**	**748**	**1.76**	**0.76**	**Not significant**

ns = not significant
Source: Researchers' fieldwork, 2014.

Table 2 above showed responses of STM teachers on applications of ICT tools in teaching of STM concepts so as to develop students' divergent thinking paradigm in STM concepts in secondary schools. It was indicated that all the item statement were not significant revealing a total average mean of 1.76. The above implication is a revelation that STM teachers do not employ ICT tools in teaching of STM concepts so as to develop students' divergent thinking paradigm in STM concepts in secondary schools. Gulbar and

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Guyen (2008) on a survey on ICT usage and the perception of social studies teachers in Turkey stressed that teachers complained of lack of technical "knowhow" associated with ICT applications.
Esu (2010) mentioned that when ICT is applied in STM teaching, it will create more access to information and experience through global network and pool of knowledge. The resistance to innovative practices such as ICT usage in STM teaching by teachers could result to not achieving the objectives of STM education which is a major detriment to the development of our nation.
HO_1: There is no significant difference between science, technology and mathematics teachers acquisition of ICT skills in developing students' divergent thinking paradigm.

Table 3: ANOVA analysis of STM acquisition of ICT skills.

Source of variation	Sum of Squares	df	Mean Square	F
Between Groups	.078	2	.039	0.007
Within Groups	1056.167	177	5.967	
Total	1056.244	179		

Source: Researchers'' field work, 2014.

The critical value of $F_{(2,177)}$ with a degrees of freedom at 0.05 level of significance is 3.040. Since the computed F-value is 0.007 which is less than the critical value. The null hypothesis is upheld indicating that there is no significant difference between science, technology and mathematics teachers acquisition of ICT skills in developing students' divergent thinking paradigm.
HO_2: There is no significant difference between science, technology and mathematics teachers application of ICT tools in developing students' divergent thinking paradigm.

Table 4: ANOVA analysis of STM application of ICT tools.

	Sum of Squares	df	Mean Square	F
Between Groups	4.078	2	2.039	0.660
Within Groups	546.917	177	3.090	
Total	550.994	179		

Source: Researchers' field work, 2014.

Table 4 is the result of the ANOVA analysis of STM teachers' application of ICT tools in developing students' divergent thinking paradigm. Using a critical value of $F_{(2,177)}$ with a degree of freedom at 0.05 level of significance is 3.040. The computed F-value 0.660 which is less than the critical value indicates that the null hypothesis is upheld. Therefore, there is no significant difference between science, technology and mathematics teachers application of ICT tools in developing students' divergent thinking paradigm.

CONCLUSION AND RECOMMENDATION

Information and Communication Technology (ICT) is an important educational content delivery tools that can develop secondary school students divergent thinking paradigm. The applications of ICT create interactive and diverse learning experiences considering students learning preferences. These in no doubt widen STM students' knowledge horizons and consciously motivate active participation during lesson interactions. In light of the findings of the study, the following are recommended;

1. Teachers should avail themselves training and retraining on the usage of innovative ICT tools in teaching STM concepts so as to develop their students' divergent thinking paradigm for sustainable and reliant citizenry.
2. Government and school owner should assist in providing avenues for training of the teachers on the use of ICT tools during classroom interactions.
3. ICT facilities should be made available in schools for STM teachers' usage.

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