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Information and Communication Technology (ICT) Capacity Building Needs for 21st Century Classroom Instructional Delivery: Perceptions of Science and Mathematics Teachers

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Abstract: This study investigated the perceptions of science and mathematics teachers on the information and communication technology capacity building needs for the 21st century classroom instructional delivery. Descriptive survey research was adopted for the study using a population of all the basic science teachers in Enugu State. A sample of 86 science and mathematics teachers was randomly selected from the fifty government secondary schools in the two education zones. An instrument titled "Personal Skills and Classroom Activities ICT Capacity Questionnaire" was used for data collection. The reliability indices for the clusters A and B of the instrument were estimated to be 0.89 and 0.78 using Cronbach alpha method. The data collected were analysed using mean and standard deviation to answer the research questions and t-test of independent samples to test the null hypothesis. The findings of the study revealed that: the capacity building needs for personal ICT skills of science and mathematics teachers include: Produce a text using a word processing programme; Use emails to communicate with others; Edit text online containing internet links and images among others while the needs for ICT skills for classroom activities include: Browse/search the internet to collect information to prepare lessons; Browse/search the internet to collect resources to be used during lessons; Use applications to prepare presentations for lessons among others. It was equally revealed that both male and female science and mathematics teachers did not differ significantly on their perceptions of the capacity building needs for both personal and ICT skills for classroom activities.

Key words: Information, communication, technology, instruction, science, mathematics

INTRODUCTION

The rapid advances in Information and Communication Technology (ICT) in this 21st century have had a profound impact on educational policies, contents, structure and methods of delivery in most developing countries such as Nigeria. They have greatly expanded learning opportunities for all age groups and have displayed a powerful potential as tools for teachers. Meanwhile, they pose new challenges to education communities for capacity-building and policy change in achieving Education For All (EFA) goals in new technology-facilitated learning environments in the emerging information society (United Nations Education Scientific and Cultural Organization) (UNESCO., 2003). The 21st century is characterised by global use of ICT facilities for instructional delivery which has expanded the scientific knowledge.

Scientific knowledge is rapidly expanding with the use of Information Communication Technology (ICT) resources and services (Etiubun and Akpan, 2017). These resources include computers, digital cameras, multimedia software applications, internet, television and videos affording services of exchange of information and knowledge, skills and ideas among other resources. These ICT resources come in many forms and are applied in a variety of ways such as in computational analysis, creation of data bank, storage of management of educational data, communication via internet, instructional materials, easy access to information enhancement of innovation and invention (Bailey, 2013). ICT has changed the way people think and learn and has helped activities to run smoothly towards achieving educational objectives. According to Etiubun and Akpan (2017), ICT is transforming how what and where learning can take place and the roles teachers and students can play to allow learning experiences flourish and be sustained. Individuals, institutions and nations are becoming more aware of the important role that teachers play in the utilization of ICTs to update classroom instructions. These resources are providing the pathway to easy access of information and changing the ways

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teachers teach and the ways students learn. These ICT resources are increasingly being put to use to enrich educational purposes. Access to internet has improved greatly through cybercafe but most individuals are not connected and the institution is yet, to be well connected as to making internet available for student's use, hence, they depend much on the cybercafé for any form of internet use.

From the foregoing, it becomes imperative to survey the ICT capacity building needs of basic science teachers for effective classroom instructional delivery. While there are many stakeholders involved in ensuring effective integration of ICT in the education system, teachers have a particularly important role to play. According to Carlson and Gadio (2002), teachers are the key to whether technology is used appropriately and effectively. Appropriate use of ICT can catalyze the paradigmatic shift from teacher-centered pedagogy to a more effective learner-centered pedagogy. Capacity building of teachers as well as administrators and managers can play a major role in enabling this shift. The focus of teacher training institute, however should not be limited to training teachers on how to use ICT rather it should provide the teachers with the skills and expertise required to use ICT to teach a curriculum which is better suited to prepare students for the 21st century.

Policy directions in most developing countries have a major focus on creating and expanding the ICT infrastructure while this helps the countries lay a foundation for integrating ICT. According to Monahan (2004) such policy directions result in an incredible influx of financial support for equipment but only a meager trickle for network support or staff training. Without a sound capacity building framework, the financial resources spent on building the infrastructure will go to waste. There are various aspects of ICT capacity building which include personal ICT skills and ICT skills for classroom activities. Personal ICT skills include: word processing, desk-top publishing, spreadsheets, school management programmes, databases, use of internet, electronic mail. According to Irfan and Noov (2012), personal or basic ICT skills refer to storage and data transfer as well as the use of word processing and electronic spreadsheet applications. ICT skills for classroom activities involve the use of internet application for communication purposes such as the use of social network, chat room and emails to communicate with others, either for learning or socializing activities. According to Terry, a knowledge of basic computer skills is necessary but not sufficient. A new teacher also needs to know and understand that computers can be used to provide.

Automation: I wrote some code for a spreadsheet once that generated up to 1500 user names from a list of names in under 10 sec. It meant that it took just a morning to generate the user names for several thousand students, a task which would have taken days, if not weeks by hand. Unless the teacher knows that such things are possible how will she think to question why a student is, say, typing out the same formula on each row of a spreadsheet? She needs to have enough of a conceptual understanding to be able to say to herself: "Surely there must be an easier and quicker way than this"?

An interactive framework in which the learner plays a full part and is not merely the passive receptacle of received wisdom. An extension of ones field of influence and knowledge: through control technology the student can control devices without even touching them and she can gather knowledge, e.g., of temperature changes during the night or of subtle correlations between sets of data that would have been to all intents and purposes, inaccessible in a bygone age.

A what-if framework in which experimentation can and should be encouraged because, in a well-constructed program, there is no risk: don't like the new figures? Click Undo. Don't like the new layout? Ditto.

These are the justifications for the ICT capacity building needs for the science and mathematics teachers for 21st century classroom instruction. The perception of the science and mathematics teachers for these ICT capacity building needs may vary by gender. According to Etiubun and Akpan (2017) knowledge gap is wide among many science teachers regarding capacity building workshop. Teacher's perception on the use of ICTs is diverse and varied and this affects the way science teachers teach. Hence, the need for the study. Specifically, the study determined the perceptions of science and mathematics teachers on their capacity building needs for personal ICT skills as well as the need for their ICT skills for classroom activities.

Research questions The following research questions guided the study:

- What are the capacity building needs for personal ICT skills as perceived by the science and mathematics teachers in Enugu State?
- What are the capacity building needs for ICT skills for classroom activities as perceived by the science and mathematics teachers in Enugu State?

Hypothesis: The following null hypothesis were tested at 5% probability level:

- H_{o1}: there is no significant difference in the mean perceptions of male and female science and mathematics teachers on the capacity building needs for personal ICT skills

- H_{02}: there is no significant difference in the mean perceptions of male and female science and mathematics teachers on the capacity building needs for ICT skills for classroom activities

MATERIALS AND METHODS

Descriptive survey research was adopted for the study using a population of all the science and mathematics teachers in Enugu State. There are a total of 246 public secondary schools in the state. A sample of 86 science and mathematics teachers was randomly selected from the 50 government secondary schools in the two education zones. An instrument titled "Personal Skills and Classroom Activities ICT Capacity Questionnaire" was used for data collection. The instrument was face validated by three validates in the Department of Science Education, University of Nigeria, Nsukka while the reliability indices of the clusters A and B of the instrument were estimated to be 0.89 and 0.78 using Cronbach alpha method. The data collected were analysed using mean and standard deviation to answer the research questions and t-test of independent samples to test the null hypothesis.

RESULTS AND DISCUSSION

The results were presented in accordance with the research questions and hypothesis that guided the study.

Research question one: What are the capacity building needs for personal ICT skills as perceived by the science and mathematics teachers in Enugu State?

Table 1 shows that the mean perceptions of the science and mathematics teachers to the items on the

Table 1: Mean and standard deviation of the perceptions of male and female basic science teachers on their capacity building needs for personal ICT skills

Items statement	Gender (Teachers)	N	Mean	SD	Decision
Produce a text using a word processing programme	Male	25	3.32	0.69	Needed
	Female	61	3.29	0.52	Needed
Use emails to communicate with others	Male	25	3.32	0.85	Needed
	Female	61	3.31	0.53	Needed
Capture and edit digital photos, movies or other images	Male	25	3.28	0.67	Needed
	Female	61	3.13	0.42	Needed
Edit text online containing internet links and images	Male	25	3.08	0.75	Needed
	Female	61	2.73	0.62	Needed
Create a database	Male	25	3.08	0.64	Needed
	Female	61	2.62	0.66	Needed
Create and/or edit a questionnaire online	Male	25	3.08	0.75	Needed
	Female	61	2.94	0.60	Needed
Organise computer files in folders and subfolders	Male	25	3.32	0.80	Needed
	Female	61	2.96	0.65	Needed
Use a spreadsheet (e.g., Excel)	Male	25	3.20	0.76	Needed
	Female	61	2.97	0.73	Needed
Use a spreadsheet to plot a graph	Male	25	3.40	0.70	Needed
	Female	61	2.96	0.51	Needed
Create a presentation with simple animation functions	Male	25	3.28	0.61	Needed
	Female	61	3.09	0.43	Needed
Create a presentation with video or audio clips	Male	25	2.76	0.83	Needed
	Female	61	3.01	0.34	Needed
Participate in a discussion forum on the internet	Male	25	3.16	0.89	Needed
	Female	61	2.78	0.60	Needed
Create and maintain blogs or web sites	Male	25	3.12	1.01	Needed
	Female	61	2.89	0.61	Needed
Participate in social networks	Male	25	3.04	0.88	Needed
	Female	61	2.47	0.69	Needed
Download and install software on a computer	Male	25	3.12	0.92	Needed
	Female	61	2.62	0.75	Needed
Download or upload curriculum resources from/to websites for students to use	Male	25	3.20	0.91	Needed
	Female	61	2.89	0.64	Needed
Teach students how to behave safely online	Male	25	3.48	0.65	Needed
	Female	61	2.72	0.64	Needed
Teach students how to behave ethically online	Male	25	3.12	0.66	Needed
	Female	61	2.65	0.69	Needed
Prepare materials to use with an interactive whiteboard	Male	25	3.04	0.93	Needed
	Female	61	2.85	0.64	Needed
Programming	Male	25	3.20	0.76	Needed
	Female	61	2.85	0.67	Needed
Overall mean	**Male**	**25**	**3.23**	**0.46**	**Needed**
	Female	**61**	**2.82**	**0.29**	**Needed**

Bold values are significant

Table 2: t-test analysis of difference in the mean perceptions of male and female basic science teachers on the capacity building needs for personal ICT skills

Gender	n	Mean	SD	df	t-cal	Sig. (2-tailed)
Male	25	3.23	0.46			
Female	61	2.82	0.29	84	1.205	0.089

Table 3: Mean and standard deviation of the perceptions of male and female basic science teachers on their capacity building needs for ICT skills for classroom activities

Item statement	Gender (Teachers)	N	Mean	SD	Decision
Browse/search the internet to collect information to prepare lessons	Male	25	3.16	0.80	Needed
	Female	61	2.69	0.76	Needed
Browse/search the internet to collect resources to be used during lessons	Male	25	3.08	0.90	Needed
	Female	61	2.97	069	Needed
Use applications to prepare presentations for lessons	Male	25	3.36	081	Needed
	Female	61	2.62	071	Needed
Create your own digital learning materials for students	Male	25	3.52	065	Needed
	Female	61	2.98	046	Needed
Prepare exercises and tasks for students	Male	25	3.36	075	Needed
	Female	61	3.03	040	Needed
Post home work for students on the school website	Male	25	3.36	070	Needed
	Female	61	2.95	045	Needed
Download/upload/browse material from the school's website	Male	25	3.40	064	Needed
	Female	61	2.83	055	Needed
Download/upload/browse material from a learning platform	Male	25	3.40	064	Needed
	Female	61	3.27	059	Needed
Communicating students learning outcome with parents online	Male	25	3.12	078	Needed
	Female	61	3.45	062	Needed
Use ICT to provide feedback and/or assess student's learning	Male	25	3.04	084	Needed
	Female	61	2.89	061	Needed
Evaluate digital learning resources in the subject (s) you teach	Male	25	3.20	076	Needed
	Female	61	2.99	072	Needed
Download/upload/browse material from the school's website	Male	25	3.32	085	Needed
	Female	61	2.97	064	Needed
Overall mean	**Male**	**25**	**3.12**	**052**	**Needed**
	Female	**61**	**2.98**	**028**	**Needed**

Bold values are significant

capacity building needs for personal ICT skills are more than 2.50 criterion mean. This means that both male and female science and mathematics teachers agree to the statements of items 1-20 as the capacity building needs for personal ICT skills. However, the overall mean perceptions of 3.23 and 2.82 for the male and female science and mathematics teachers, respectively show that there is a variation in the perceptions of male and female teachers:

- H_{o1}: there is no significant difference in the mean perceptions of male and female science and mathematics teachers on the capacity building needs for personal ICT skills

Table 2 reveals that the male and female science and mathematics teachers do not differ in their opinion on the capacity building needs for ICT skills for personal ICT skills $t(84) = 1.205$, $p = 0.089$. This means that there is no significant difference in the mean perceptions of male and female science and mathematics teachers on the capacity building needs for personal ICT skills.

Research question two: What are the capacity building needs for ICT skills for classroom activities as perceived by the science and mathematics teachers in Enugu State?

Table 3 shows that, the mean perceptions of the science and mathematics teachers to the items 1-12 which boarder on the capacity building needs for ICT skills for classroom activities are more than 2.50 criterion mean. This means that both male and female science and mathematics teachers agree to the statements of items as the capacity building needs for ICT skills for classroom activities. However, the overall mean perceptions of 3.12 and 2.98 for the male and female science and mathematics teachers, respectively show that there is a variation in the perceptions of male and female teachers with respect to the ICT skills for classroom activities.

- H_{o2}: there is no significant difference in the mean perceptions of male and female science and mathematics teachers on the capacity building needs for ICT skills for classroom activities

Table 4 reveals that, the male and female science and mathematics teachers do not differ in their opinion on the capacity building needs for ICT skills for classroom activities $t(84) = 1.402$, $p = 0.075$. Thus, there is no significant difference in the mean perceptions of male and female science and mathematics teachers on the capacity building needs for ICT skills for classroom activities.

Table 4: t-test analysis of difference in the mean perceptions of male and female basic science teachers on the capacity building needs for ICT skills for classroom activities

Gender	n	Mean	SD	df	t-cal	Sig. (2-tailed)
Male	25	3.12	0.52			
Female	61	2.98	0.28	84	1.402	0.075

The findings of the study revealed that the capacity building needs for personal ICT skills of science and mathematics teachers include; Produce a text using a word processing programme; Use emails to communicate with others; Capture and edit digital photos, movies or other images; Edit text online containing internet links and images; Create a database; Create and/or edit a student's assignment online; Organise computer files in folders and subfolders; Use a spreadsheet (e.g., Excel); Use a spreadsheet to plot a graph; Create a presentation with simple animation functions; Create a presentation with video or audio clips; Participate in a discussion forum on the internet among others. Similarly, it was revealed that the capacity building needs of science and mathematics teachers for ICT skills for classroom activities include: Browse/search the internet to collect information to prepare lessons; Browse/search the internet to collect resources to be used during lessons; Use applications to prepare presentations for lessons; Create your own digital learning materials for students; Prepare exercises and tasks for students; Post home work for students on the school website; Download/upload/browse material from the school's website; Download/upload/browse material from a learning platform; Communicating students learning outcome with parents online among others.

These findings are apt considering the nature of the 21st century classrooms. This century is the type in which everything is going global including teaching and learning. Thus, for teachers to adjust in their pedagogical activities, these personal ICT skills are needed. Buttressing this finding (Etiubun and Akpan, 2017) recommended that every teacher irrespective of discipline is expected to possess the basic or personal ICT skills in order to cope with the demand of 21st century teaching and learning. This is also in line with the findings of Irfan and Noov (2012). Also, UNESCO. (2003) has made recommendations for the training of Science teachers on both personal and ICT skills for classroom activities. These findings also agree with Gibbons *et al*. (2004) that experiments and laboratory simulations can be accomplished through using ICTs as this enhances teacher preparation of instructional delivery. In order words, availing science teachers of the opportunity of ICT capacity building workshops of training will go a long way to equip their skills on ICTs for both personal use and classroom activities.

CONCLUSION

The researchers concluded based on the findings of the study that personal and well as ICT skills for classroom activities are the needed capacity buildings for the science and mathematics teachers in Enugu State for them to adapt in the 21st century classroom instructional demands. Thus, the following recommendations are made:

RECOMMENDATIONS

State government should make effort to finance the training of science and mathematics teachers on the personal ICT skills in order to equip them for the twenty first century classroom challenges. Workshops or seminars should be organized at either state or zonal level to train science and mathematics teachers on the ICT skills for classroom activities. State education authorities should try and make laptop computers available for the science and mathematics teachers.

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