Chemistry teachers' utilization and perceptions of integration of information and communication technology in teaching and learning

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ABSTRACT
The study was carried out to investigate chemistry teachers' utilization and perceptions of the integration of ICT facilities in teaching and learning in secondary schools in the Nsukka local government area of Enugu State. Three research questions and one hypothesis guided this study. A descriptive survey design was adopted for the study. The sample of the study consisted of 25 chemistry teachers in public secondary schools. The instrument for data collection was a questionnaire titled Utilization and Perception of Integration of Information Technology in the Teaching and Learning of Chemistry (UPIICTTLC). The data collected were analysed using mean scores and standard deviations, while the null hypothesis was tested using t-test statistics at the 0.05 level of significance. The findings of the study, among others, revealed that chemistry teachers' utilization of ICTs is low, chemistry teachers have a positive perception towards integrating ICT in teaching and learning, and there is no gender difference with respect to the utilization of ICTs. Based on the findings, the researchers conclude that there is a need for adequate provision and utilization of ICT facilities and recommend that the provided ICT facilities should be properly utilized for the teaching and learning of chemistry.
Keywords: Academic achievement, Chemistry, utilization, ICT tools and perception

Introduction

Chemistry education is the study of the teaching and learning of chemistry in schools (Aji, 2022). It is concerned with the imparting of knowledge on properties, components, transformations, and interactions of matter (Umate, Aminu, & Hmza, 2018). Chemistry education fosters scientific literacy. Chemistry education plays a vital role in enhancing the quality of teaching, research, and development, as well as ensuring that students are equipped with good knowledge to produce intensive goods and services to meet human needs for food, health care products, and other materials aimed at improving the quality of life (Khanam, 2018). Adesoji and Olantubosun (2008) claim that chemistry is important to the scientific and technological development of any nation and that the effective teaching of chemistry can lead to the attainment of scientific and technological greatness. Chemistry education emphasizes

the development of pedagogical skills such as lesson planning, curriculum design, and assessment strategies, as well as chemistry content knowledge (Chemistry Education Curriculum, Anchor University, 2024).

Chemistry education is important because the field of chemistry is fundamental to the global development of the world including advancement therapeutic science. The laws of chemistry govern nearly all natural and synthetic process from drug interaction in the human body to the formulation medical treatments (Oleyele et al., 2021). Chemistry is a pure science that deals with the study of the composition, properties, and uses of matter (Ababio, 2016), including the activity of organic and inorganic substances and various elementary forms (Watson ,2019).

According to Patrick, (2023), one of the key contributions of chemistry lies in drug design and pharmacology, where medicinal chemistry facilitates development life saving pharmaceuticals. For instance, penicillin (the first antibiotic) and remdesivir (an antiviral for COVID-19), exemplify how principles of chemical reactions combat pathogens and save lives. Additionally, natural product chemistry harnesses healing compound from nature such as taxol from yew trees, which serves as potent chemotherapy agent (Newman & Cragg, 2020). Therefore, chemistry education drives both scientific innovation as well as equips future scholars and healthcare professionals to develop research based therapeutic intervention to improve global health outcomes.

Research has also demonstrated that Chemical knowledge is applied across diverse areas of specialization and in problem-solving (Aji, 2022). For instance, Aji (2023) and Umate, Eya, and Okebanama (2019) reported that knowledge of chemistry finds application in the following areas of specialization: agriculture, energy supply, pharmacy, medicine, clothing, and water supply. It is one of the core science subjects taught in all the senior secondary schools in Nigeria (Achimugu, 2016). Because of its importance, it is made compulsory for students of science and science-related disciplines. In fact, the Nigerian Joint Administration Matriculation Board (JAMB) requires a pass at the credit level in chemistry at the Senior Secondary School Certificate Examination (SSCE) as a minimum requirement for being admitted to science and science-related courses.

Because of the importance of chemistry, it is expected that students will perform better in chemistry. However, students' achievement in chemistry has been reported to be unsatisfactory (Kyado, Achor, & Adah, 2021; Nartey & Hanson, 2021). According to the WAEC Chief Examiners' report from 2017–2024, chemistry students' performance was fluctuating, and performance for most has been below 50%. Badmus and Omosewo (2018) also reported that students' performance in chemistry from 2007–2017 was below 50%, except for 2013, 2014, and 2015, which were 72%, 62%, and 60%, respectively. This is because students perceive chemistry as difficult and abstract (Umate, Abubakar and Abonyi, 2022). According to researchers, the reason why chemistry is perceived as difficult and abstract is the way it is being presented to students (Ezeliora, 2019). The abstract nature of chemistry calls on chemistry teachers to make the subject concrete and real to students by using a variety of information and communication technologies (ICT), as reported by Umate, Abubakar, and Abonyi (2022).

ICTs are electronic devices and interactive materials that could be used for teaching, learning, and personal use. According to Ojha (2016), ICT is a term that includes all technologies for the manipulation and communication of information. ICT is a science of information that uses computers and multi-electronic resources to collect, process, store, retrieve, transmit, or disseminate information to any part of the world (Odike, Nnabuchi, &

Okolo, 2023). It is an important tool for improving students' performance and developing participatory skills (Toma et al., 2023). Because of the role of ICT tools in teaching and learning, the Enugu State government, in collaboration with United Nations Educational, Scientific and Cultural Organization (UNESCO), put ICT tools in public secondary schools (Enugu State Ministry of Education, 2022). Umennuihe et al. (2023) reported that ICT tools are adequately available in public schools in Enugu State.

Studies revealed that students' ICT skills establish that ICT-based learning environments play a significant role in education (Dori, Rodrigues, & Schanze, 2013). Gupta (2023) reported that ICT tools & software help in better understanding of concepts of chemistry because they help students to visualize the chemical structures in 3D. It helps learners or researchers to understand the practical meaning of chemistry. When ICT facilities are efficiently utilized, they enhance students' problem-solving skills and arouse their interest in study (Bature, 2016). Umate, Abubakar, and Abonyi (2022) reported that ICT facilities help in concretizing abstract chemistry concepts, thereby reducing difficulties. Therefore, when chemistry teachers use ICT tools effectively in teaching and learning, students more readily achieve understanding of chemistry concepts.

The teachers' perception of ICT integration in teaching and learning is a key drive for promoting the utilization of ICTs for teaching and learning. An ICT-incorporated instructional strategy enhances teachers' pedagogical practices, makes the learning process inspiring and interactive, and keeps learners motivated (Akram et al., 2022; Ngao, Sang, & Kihwele, 2022). Many studies have reported that ICT-integrated instructional approaches increase students' motivation, conceptual understanding, academic achievement, and engagement (Akram et al., 2022; Xu et al., 2021).

The utilization and perception of ICTs integrated into teaching and learning faced many challenges, as reported by researchers. Some of these challenges include insufficient knowledge of how to use ICT facilities; poor internet connections; inadequate availability of ICT materials; teachers' lack of confidence in using ICT tools; poor infrastructure; and weak policy, among others, as reported by some studies (Akram et al., 2022; Ngao, Sang, & Kihwele, 2022; Ebire, 2020; Umate, Aminu, & Hamza, 2018). Ebire (2020) reported that outdated government policies to support ICT use in science and mathematics posed a big challenge, and more consequentially, the inadequate skills of teachers in using ICT tools.

The utilization and integration of ICT facilities in teaching and learning might also be dependent on the teacher's gender. Research has revealed that gender stereotypes hinder the active utilization of ICT in teaching and learning (Buskens & Webb, 2009; Edwina, 2005). Some studies reported that male lecturers utilize ICT facilities more than female lecturers (Manyilizu, Dodoma, Gilbert, 2015; Mahdi & AlDera, 2013). Other studies reported the opposite (David-West & Akameze, 2022; Morley, 2011), and some studies did not reveal gender differences in ICT usage (Qazi, 2021; Yushau & Nannim, 2020; Gebhardt, Thomson, Ainley, & Hillman, 2019).

There are a lot of studies, across nations and disciplines, on teachers' utilization and perceptions of the integration of ICTs in teaching and learning. Bayuo et al. (2022) found that Ghanian chemistry teachers' utilization of ICT in teaching and learning was low. Molotsi (2022) reported that South African teachers exhibited limited use of ICT resources to transform teaching. Ngoungouo (2017) revealed that Cameroonian teachers have limited use of ICT resources in their teaching. Yunus et al. (2010) reported that Malaysian English language lecturers demonstrated positive perceptions of the use and integration of ICTs in teaching and

learning. Akram et al. (2022) reported that Pakistani teachers exhibit positive perceptions toward integrating ICTs in teaching and learning practices.

Olelewe and Amaka (2011) found that computer educators utilize ICT effectively as a tool in their teaching and learning, basically in instructional delivery and the individualized learning process. Obinna and Mogboh (2021) revealed that the lecturers' utilization of ICT facilities in teaching and learning was low. Ameen, Adeniji, and Abdullahi (2019) disclosed that mathematics teachers in Kwara State, Nigeria, utilized ICT facilities for the teaching and learning of mathematical concepts. Ezeuwa (2014) revealed that ICT facilities were not adequately utilized in Ebonyi State public primary schools. Gaya, Bala, Auwal, and Salisu (2020) found that both male and female mathematics teachers in Kano State effectively utilized ICT facilities in teaching and learning. Ibrahim and Usman (2023) revealed that science and technical teachers in northeastern Nigeria do not utilize ICT facilities for teaching and learning.

The review of the of the literature revealed that most studies on the utilization and perception of integration of ICTs in teaching and learning were carried out with foreign samples, whose results might not be generalizable to Nigeria. Some of these studies were conducted with samples from disciplines other than chemistry, whose applications of ICTs might not be the same as those of chemistry. The results of these studies are also contradictory, suggesting that further study is needed. Furthermore, in Nigeria, few studies were conducted with university lecturers whose ICT skills and capabilities might not be the same as those of the chemistry teachers who constituted the sample of this study. Therefore, the results of these previous studies might not be applicable to the present study. These are the pressing gaps in the literature that necessitated this study, which will significantly contribute to the literature in the field of science education on the utilization of ICTs in the teaching and learning of chemistry.

Research Questions

The following research questions were raised to guide this study

1. To what extent are the available ICT facilities used in teaching and learning of chemistry?
2. What are the mean responses of chemistry teachers towards integration of ICT facilities in the teaching and learning process?
3. What are the challenges faced by teachers in integrating ICT facilities into the teaching and learning of chemistry in secondary schools in Nsukka L.G.A?

Hypothesis

The following null hypothesis was formulated and tested at *0.05* level of significance

HO_1: There is no significance difference in the mean response of male and female teachers on the extent of use of ICT facilities in teaching and learning of chemistry.

Method

A descriptive survey research design was adopted for the study. Descriptive survey research, according to Nworgu (2015), is a research design that involves collecting and analysing data from only a few people or items considered to be representative of the entire population. A descriptive survey design was considered appropriate as it enabled the researchers to obtain first-hand primary information from a large population of respondents in their natural setting. The study was carried out in the public secondary schools in Nsukka Local Area of Enugu State. The population of this study is made up of all the chemistry teachers in

the Nsukka Local Government Area. According to the Post Primary School Management Board (PPSMB, 2023), the population of chemistry teachers in Nsukka LL.G.A.is 30. However, at the time of carrying out this study, only 25 chemistry teachers were available.

The instrument for data collection was the Utilization and Perception of Integration of Information Communication Technology in the Teaching and Learning of Chemistry (UPIICTTLC). The UPICTTLC consisted of two sections: sections A and B. Section A contains information on the personal data of the respondents, like school, and gender. Section B contains three clusters: A, B, and C. Cluster A is a 4-likert scale of 17 items on the extent of utilization of ICT facilities. Cluster B is a 4-likert scale of 11 items on the chemistry teacher's perception towards the integration of ICT facilities in the teaching and learning of chemistry. Cluster C is a 4-Likert survey of 14 items on the challenges of the utilization of ICT in the teaching of chemistry. The scoring pattern for cluster A is Very High Extent (4), HE: High Extent (3), LE: Low Extent (2), and VLE: Very Low Extent (1). The scoring guide for the clusters B and C is Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Strongly Disagree (SD) = 1.

The UPIICTTLC was validated by three experts, two from the Science Education Department and one from Measurement and Evaluation, all from the University of Nigeria, Nsukka. The comments, corrections, and suggestions were used to restructure and reframe the instrument to produce the final copy of the instrument for this study. The validated UPICTTLC was subjected to trail-testing using 15 chemistry teachers from public schools in Igbo Eze North local government, which is outside the study area. The Cronbach Alpha method was used in computing the reliability of UPIICTTLC, and reliability estimates of 0.79, 0.83, and 0.71, respectively, for clusters A, B, and C were obtained.

The copies of UPIICTTLC were administered directly to the respondents (chemistry teachers) by the researcher. The researcher administered the instrument directly to the respondents and also retrieved them on the spot. After the administration, the entire questionnaire was collected for further analysis. The mean and standard deviation were used to answer the research questions. An independent sample T-test was used for testing hypotheses. The real limit of the range 1-1.49 (VLE), 1.50-2.49 low extent, 2.50-3.49 high extent, and 3.50-4.0 high extent was for cluster A. The decision rule for clusters B and C is that any item with a mean benchmark of equal to or greater than 2.5 is considered to be accepted, while an item statement with a mean benchmark of equal to or less than 2.49 is considered to be disagreed with or rejected.

Results

Research question one: To what extent are the available ICT facilities utilized in teaching and learning of chemistry?

Table 1: Mean and standard deviation of respondents on the utilization of available ICT facilities in teaching and learning of chemistry.

S/N	ITEMS	MEAN	STANDARD DEVIATION	DECISION
1	Computer	1.60	.52	LE
2	Microphones	2.40	.97	LE
3	Projector	1.70	.82	LE
4	Internet	2.00	1.05	LE
5	Chemdraw	1.50	.71	LE
6	MS Access	1.50	.71	LE
7	Presentation remote clicker	1.10	.32	VLE
8	Software packages	1.40	.90	VLE

9	Mobile phones	1.90	1.19	LE
10	Computer hardware	1.30	.67	VLE
11	Scanner	1.30	.48	VLE
12	Digital camera	1.40	.52	VLE
13	MS Excel	1.30	.48	VLE
14	Video camera	1.40	.52	VLE
15	Television	1.40	.70	VLE
16	CD ROM	1.40	.70	VLE
17	Microsoft power point	1.40	.70	VLE
Grand mean and SD.		1.52	0.70	LE

The result in Table reveals items 1-6 and 9 have mean values ranging from 1.50 to 2.40, which fall within a low extent of utilization. This implies that the extent of utilization of the following ICT facilities is low: computers, microphones, projectors, internet, ChemDraw, MS Access, and mobile phones. Items 7-8 and 10–17 have mean values ranging from 1.10 to 1.40, which fall within a very low extent of utilization. This implies that the extent of utilization of the following ICT facilities is very low: presentation remote clicker, software packages, computer hardware scanner, digital camera, MS Excel, video camera, television, CD ROM, and Microsoft Power Point. The grand mean is 1.52, which falls within the low extent of utilization. This implies that chemistry teachers' utilization of ICT facilities in the teaching and learning of chemistry is low.

Research question two: What are the mean rating scores of chemistry teachers towards integration of ICT facilities in the teaching and learning process?

Table 2: Mean and standard deviation of chemistry teachers' perception towards integration of ICT facilities in teaching and learning of chemistry.

S/N	ITEM STATEMENT	MEAN	STANDARD DEVIATION	DECISION
1	The utilization of ICT makes teaching and learning of chemistry simple	3.60	.70	Agreed
2	It feels safer to use ICT in teaching and learning of chemistry	3.20	.63	Agreed
3	ICT makes teaching and learning of chemistry more comprehensible for students	3.30	.48	Agreed
4	I like using ICT to teach chemistry because it saves time	3.20	.63	Agreed
5	Incorporating ICT into lesson plans allows full attainment of objectives	3.30	.48	Agreed
6	I like using ICT to teach chemistry because it makes it concise	2.80	.79	Agreed
7	I like using ICT to teach chemistry because it aids good classroom management and organization	3.50	.71	Agreed
8	Using ICT in teaching is less expensive	2.10	1.29	Disagree
9	Teaching is enjoyable while using ICT	2.80	.92	Agreed
10	Some chemistry teachers like using ICT to teach because it makes it concise	2.80	.79	Agreed

11	Hardware and software often disrupt teaching	1.90	1.20	Disagree
Grand mean and SD		2.95	0.78	Agreed

The results in Table 2 revealed that the item statements in 1, 2, 3, 4, 6, 7, 9, and 10 had mean values ranging from 2.800 to 3.600, which indicate a positive perception towards the integration of ICT facilities in the teaching and learning of chemistry. Items 8 and 11 have mean values ranging from 1.20 to 1.29, which indicate a negative perception toward the integration of ICTs in teaching and learning. The grand mean has a value of 2.95 and a standard deviation of 0.78, and this value falls within the range of positive perception. This implies that chemistry teachers have a positive perception of the integration of ICT facilities in the teaching and learning of chemistry.

Research question three: What are the challenges faced by teachers in integrating ICT facilities into the teaching and learning of chemistry in secondary schools in Nsukka Local Government Area.

Table 3: Mean and standard deviation of respondents on the challenges of ICT use in the teaching and learning of chemistry.

S/N	Item Statement	Mean	Standard Deviation	Decision
1	Insufficient knowledge of how to use ICT facilities	3.70	.48	Agreed
2	Poor infrastructure	3.50	.71	Agreed
3	Weak policy	3.30	.82	Agreed
4	Limited number of chemistry teachers who are ICT proficient	3.10	.74	Agreed
5	Low telecommunication service penetration	3.70	.48	Agreed
6	Poor internet connections	3.60	.70	Agreed
7	Domination of chalk board	3.80	.42	Agreed
8	Short supply of ICT facilities	3.70	.67	Agreed
9	Domination of textbooks	3.60	.52	Agreed
10	Inadequate availability of ICT materials	3.40	1.00	Agreed
11	Lack of technical know how	3.60	.48	Agreed
12	Teachers' lack of expertise with ICT tools	3.40	1.00	Agreed
13	Teachers' lack of confidence in using ICT tools	3.70	.48	Agreed
14	Insufficient knowledge of appropriate software to apply	3.40	.84	Agreed
Grand mean and SD		3.53	0.67	Agreed

The results in Table 3 revealed that the item statements from 1–14 had a mean range of 3.1–3.8, indicating that chemistry teachers agreed that all the items were the challenges of ICT utilization and its perception of integration in the teaching and learning of chemistry.

Hhypothesis one: There is no significant difference in the mean response of female and male teachers on the extent of the utilization of ICT facilities in the teaching and learning of chemistry.

Table 4: Independent sample t-test for male and female chemistry teachers' utilization of ICT in teaching and learning of chemistry.

Gender	No	Mean	Standard deviation	Df	t-value	p-value	Decision
Male	13	32.5	0.39	23	0.64	0.85	Not significant
Female	12	28.4	0.33				

Table 4 displays an independent sample t-test analysis of the mean responses of male and female chemistry teachers' utilization of ICT in teaching and learning of chemistry: t (2, 23) =0.64, p = 0.850 > 0.05. Since the observed p-value of 0.85 is greater than the significant p-value of 0.05, the null hypothesis is accepted. Therefore, there is no significant influence of gender on teachers' utilization of ICT facilities in the teaching and learning of chemistry.

Discussion of Results

One of the results of this study revealed that chemistry teachers' utilization of ICT facilities in teaching and learning is low. This implies that chemistry teachers do not properly and adequately use ICT facilities in teaching and learning. This result is in agreement with the findings of some previous studies (Yushau & Nannim, 2020; Obinna & Mogboh, 2021; Ibrahim & Usman, 2023; Bayuo et al., 2022; Molotsi, 2022; Ngoungouo, 2017), which also reported that teachers' utilization of ICT facilities in teaching and learning is low. The reason for this result might be because chemistry teachers are either not willing to use ICT facilities or lack ICT expertise and confidence for teaching some chemical concepts.

Another result of this study revealed that chemistry teachers have a positive perception towards the integration of ICT facilities in teaching and learning. This implies that chemistry teachers have ideas about the importance of ICT integration in teaching and learning. This result supports the findings of some studies in the literature (Yunus et al., 2010; Akram et al., 2022), which also found that teachers have a positive perception towards ICT integration in teaching and learning. The reason for this result might be because chemistry teachers have the knowledge and ideas for integrating ICTs in teaching and learning, thus showing a positive perception.

This study also revealed that certain challenges militate against the utilization of ICT facilities and their integration in teaching and learning, including insufficient knowledge of how to use ICT facilities; poor infrastructure; weak policy; poor internet connections; and teachers' lack of expertise with ICT tools, among others. The result of this study is in agreement with the results of earlier studies in the literature (Akram et al., 2022; Ngao, Sang, &Kihwele, 2022; Ebire, 2020; Umate, Aminu, & Hamza, 2018). The result is also in agreement with the finding of Ebire (2020), who reported that outdated government policies and inadequate skills of teachers in using ICT tools posed a big challenge to their utilization in teaching and learning.

In this study, there was no significant gender difference among chemistry teachers in the utilization of ICT facilities in the teaching of chemical concepts. In the context of this study, both male and female chemistry teachers' utilization of ICT facilities in teaching chemical concepts is low. This result is consistent with the findings of some studies (Qazi, 2021; Yushau & Nannim, 2020; Gebhardt, Thomson, & Ainley, Hillman, 2019), which did not reveal gender differences among teachers on their utilization of ICT facilities for teaching and learning.

Conclusion

From the results of this study, it can be concluded that both male and female chemistry teachers' utilization of information and communication technology is low. But they have a

positive perception of the integration of ICT tools in teaching and learning. Teachers' lack of expertise with ICT tools, poor infrastructure, weak policies, and poor internet connections, among others, are some of the challenges militating against the utilization of ICTs for teaching and learning. Considering the importance of ICT tools in concretizing the abstractness of chemistry concepts and in making learners actively participate in learning processes, the study recommends training chemistry teachers through in-service workshops, seminars, and conferences organized by the state ministry of education and other educational stakeholders.

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