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## INVESTIGATING CHEMISTRY TEACHERS' PEDAGOGICAL KNOWLEDGE ON ICT, AMONG GUSAU AND TALATA MAFARA EDUCATIONAL ZONES OF ZAMFARA STATE, NIGERIA

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### Abstract

*This study investigated chemistry teachers' pedagogical knowledge on ICT among Gusau and Talata Mafara Educational zones of Zamfara State. The research outlined three objectives, answered three research questions and tested two null hypotheses. A descriptive survey research design was used. The instrument used was test of chemistry teachers' pedagogical knowledge on ICT. The instrument was validated by experts in science education, computer science and measurement and evaluation, yielding a reliability index of 0.79 on the cronbach alpha analysis. Statistical analyses including Mean, Standard deviation, one-way analysis of variance and independent T-test were conducted using SPSS version 20. The results indicated a low level of pedagogical knowledge on ICT among chemistry teachers in Gusau and Talata Mafara Educational Zones. Additionally, the study revealed that teachers' gender and qualifications do not significantly impact their pedagogical knowledge on ICT. In the end, the study Recommended among other things, the organization of training, seminars, conferences, and workshops by the government and educational stakeholders to enhance teachers' pedagogical knowledge on ICT. Furthermore, advocating for the provision of ICT facilities in schools for instructional purposes and ensuring secondary school teachers are equipped with laptops and other ICT materials are suggested measures to enhance the quality of education in Gusau and Talata Mafara Educational zones of Zamfara State.*

**Keywords:** Pedagogical Knowledge (PK), Information and Communication Technology (ICT), Teaching of Chemistry

## INTRODUCTION

The word pedagogy has been defined variously by many scholars, Pedagogy as seen in Shah, (2021) is derived from two Greek words 'Paidagoge' paid meaning a 'child' and 'agoge' meaning 'lead', so pedagogue was literally means 'a leader of children'. Pedagogical knowledge according to Shulman, (2004) includes knowledge of an understanding or comprehending of how students' learn, knowledge or fact of how to develop and implement lesson plan, knowledge of assessment of students' learning styles, techniques and general classroom management abilities and skills. Pedagogy is an act of teaching with confidence using certain techniques, strategies, and technologies to attain pedagogical goals. Iwu, (2006) noted that the use of ICT tools enhances the pedagogical achievement of the objectives set by the teachers at all levels of education within a short time. Successful integration of ICT in the school system depends largely on the knowledge of teachers towards the role of modern technologies in teaching and learning. Agbetuyi and Oluwatayo, (2012) opined that ICT compliance encompasses not only the mastery of technical skills and techniques, but the understanding of how to apply these skills judiciously and responsibly in facilitating pedagogical experiences. Thus, the role of pedagogical knowledge on ICT for chemistry teachers cannot be over emphasized.

Chemistry is one of the natural sciences that study everything about the matter which includes structure, composition, dynamics, change, and energy which involves skill and reasoning (Tuysuz, Ekiz, Bektas, Uzuntiryaki, & Tarkin, 2011). Chemistry is a science subject that links all other sciences and provides the major workforce needs of a nation. Its applications can be seen daily (Odukwe & Nwafor, 2022). Chemistry as a scientific discipline is essential in the areas of medicine, clothing, housing, oil exploration, food production, and storage. This implies that the knowledge and skills acquired from chemistry help man in exploring their daily life activities solve problems in their natural environment, and contribute to the community and national development.

Information and communication technology (ICT) is the abbreviation for computers, software networks, satellite communications, and associated technologies that enable people to access and exchange information and knowledge in many formats (Ghavifekr & Rosdy, 2015). ICT is a technology used to access, collect, and process, modify, display, and transmit information (Ademiluyi, 2019). ICT refers to all digital equipment or tools, contents, forums, resources, and applications that may be utilized to attain teaching and learning objectives, increase access to and reach of resources, develop capabilities, and administer educational systems (FRN, 2012). Oke (2013) and Oyebanji (2013) acknowledged the significance of information and communication technologies in the educational sector as it can be used to achieve educational objectives, improve the quality of learning, advance teachers' professional development, and increase students' self-efficacy and their ability to learn independently. According to Kwache (2017), the use of ICT in the field of education strengthens students' abilities, boosts learning engagements and tailored training, and improves teaching and learning via its dynamic, adaptable, interactive, and engaging content. According to Al-Hariri and Al-Hattami, (2017), the use of technology has a positive impact on students' ways of thinking, and there exists a significant relationship between students' use of technology and their performances. Similarly, Ghavifekr and Rosdy (2015) showed that

the use of ICT enhances students' engagement and their academic performance.

The use of ICT in education and chemistry in particular can improve the quality of learning by improving the acquisition of fundamental skills, improving motivation and engagement, and bolstering teachers' continuing education (Bortnik et al., 2017; Chittleborough, 2014; Gambari et al., 2016; Meesuk & Srisawasdi, 2014; Ratamun & Osman, 2018). These therefore underscore the need for chemistry teachers to have pedagogical knowledge of utilizing ICT tools for effective instructional delivery. Moreover, according to Ellermeijer and Tran (2019), the use of ICT in chemistry instruction helps to enhance the quality of knowledge, making it more applicable, less difficult, and more connected to real-life issues than the conventional method of teaching. The importance of ICT has brought about rapid changes in technology, social, political and global economic transformation. ICT had impacted on the quality of teaching, learning and research education. ICT provides opportunities for students, teachers, academic and non-academic staff to communicate with one another regarding their school matters.

## Statement of the Problem

Chemistry is one of the most important subjects in science and contains a number of abstract concepts many of which are not applicable outside the classroom (Stieff & Wilensky, 2003). Helping students understand scientific ideas and chemical phenomena is the purpose of every chemistry teacher (Barak, 2007). Numerous studies conducted in Nigeria indicate that a significant number of teachers lack proficiency in ICT literacy (Oluwagbohunmi, 2013; Obielodan et al., 2020). It's evident that teachers with such limitations face considerable challenges in providing the necessary education and training required for the information age in the 21<sup>st</sup> century.

The corona virus pandemic was first identified in December 2019 and later known as covid-19. The pandemic spread globally, leading to lockdowns worldwide. Consequently, all sectors including education in Nigeria were adversely affected. Schools, colleges and universities were closed, bringing the teaching and learning process to a halt. However, some developing countries employed ICT tools to support teachers and students. Consequently, online classes were initiated, contributing to the rejuvenation of the education system in developed nations. Unfortunately, a few under developed countries including Nigeria in general and Zamfara state in particular, lagged behind as they did not fully embrace this technological advancement. Therefore, the researcher considered it necessary to assess or investigate the pedagogical knowledge of chemistry teachers on ICT among Gusau and Talata Mafara educational zones of Zamfara state, Nigeria.

## Objectives of the Study

The study aimed to achieve the following objectives:

1. To determine the level of chemistry teachers' pedagogical knowledge on ICT
2. To find out the effect of chemistry teachers' qualification on their pedagogical knowledge on ICT
3. To determine the influence of gender on chemistry teachers' pedagogical knowledge on ICT

## Research Questions

The following research questions guided the study:

- What is the level of chemistry teachers' pedagogical knowledge on ICT?
- Does chemistry teachers' qualification has any effect on their pedagogical knowledge on ICT?
- What is the difference between male and female chemistry teachers' pedagogical knowledge on ICT?

### Null Hypotheses

**Ho<sub>1</sub>** Chemistry teachers' qualification has no significant effects on their pedagogical knowledge on ICT

**Ho<sub>2</sub>** There is no significant difference between male and female chemistry teachers' pedagogical knowledge on ICT

## Review of Related Literature

Oluwagbohunmi, (2013) examined the ICT knowledge and competence of social studies educators in Ekiti State, Nigeria and the study found that social studies educators' knowledge of ICT was very low and they lack necessary skills for its usage and therefore recommended that government should make computer literacy compulsory for all educators in secondary schools and ensure adequate and regular power supply. Obielodan, Omojola, Kazeemtijani and Samuel, (2020) investigated on teachers' pedagogical knowledge of utilization of information and communication technology in Kwara State, Nigeria and the study found out that teachers had low pedagogical knowledge of the use of ICT for teaching. And the study recommended that government and non-governmental organizations should endeavor to procure and distribute relevant information and communication technologies to schools for effective teaching and learning purpose. Educational administrators should also provide enabling environments within the setting to aid frequent use of ICT for instruction and specialized training should be organized to improve teachers' pedagogical knowledge of ICT tools for instructional purposes.

Similarly, Enu, Nkum, Ninsin, Diabor and Korsah (2018) investigated on teachers' ICT skills and ICT usage in the classroom and found that teachers hardly use technology in their lessons because of not having ICT integration skills as well as lack of resources in the basic schools. The study recommends the need for regular in-service training program for teachers with a direct focus on ICT integration and ICT usage for teaching and learning. Mailiza and Fan, (2020) investigated on the Indonesian secondary teachers' knowledge in the use of ICT in secondary mathematics classrooms and found out that secondary mathematics teachers have a largely inadequate knowledge of ICT and knowledge of ICT usage in teaching.

## Methodology

The study employed a descriptive survey design, focusing on the chemistry teaching landscape within Gusau and Talata Mafara educational zones of Zamfara state. The targeted population comprised 135 chemistry teachers. A sample of 108 teachers was derived from the research Advisors' Table (2006), consisting of 76 males and 32 females. Further categorization revealed that 37 teachers obtained N.C.E qualifications, 56 possessed BSc.Ed qualifications, and 15 obtained BSc with PGDE qualifications. To gauge pedagogical knowledge on ICT, the study utilized a well-structured instrument named (Chemistry Teachers' Pedagogical

Knowledge on ICT Test). The instrument had a reliability of 0.79, affirming its suitability for the research.

### Results:

**Research question 1:** What is the level of chemistry teachers' pedagogical knowledge on ICT?

**Table 1:** A summary of frequency and percentage of Chemistry Teachers' PK on ICT level in Gusau and Talata Mafara Education Zones, Zamfara state

PCK Level on ICT	Frequency (N)	Percentage (%)	Decision
Low	74	68.5%	Highly prevalent
Moderate	24	22.2%	Fairly
High	10	9.3%	Poor
<b>Total</b>	<b>108</b>	<b>100.0%</b>	

### Field work (2023)

Table 1 is the summary of descriptive statistics of frequency and percentage computed to determine the level of chemistry teachers' PK on ICT among Gusau and Talata Mafara Educational Zones of Zamfara state. The analysis revealed that 74(68.5%) of the chemistry teachers involved in the study have low PK on ICT; 24(22.2%) have moderate PK on ICT and 10(9.3%) have high PK on ICT. Therefore, since 68.5% of the 108 chemistry teachers demonstrated low PK on ICT in Gusau and Talata Mafara educational zones, the study have evidence that chemistry teachers in Gusau and Talata Mafara Educational Zones have low PK on ICT.

**Research question 2:** Does chemistry teachers' qualification has any significant effects on their pedagogical knowledge on ICT?

**Table 2:** A summary of Mean and standard deviation of Chemistry Teachers' PK level on ICT base on their qualification among Gusau and Talata Mafara Education Zones, Zamfara state.

Qualification	N	Mean	Std. Dev.	Mean Difference
NCE	37	9.78	8.337	0.49
B.Sc.Ed	56	8.89	7.852	0.40
B.Sc with PGDE	15	9.20	8.809	0.09
<b>Total</b>	<b>108</b>	<b>9.29</b>	<b>8.087</b>	<b>0.98</b>

### Field work (2023)

Table 2 is the summary of descriptive statistics of Mean and Standard Deviation conducted to determine the effect of chemistry teachers' qualification on their PK level on ICT. The analysis revealed that there was a very small amount of mean difference of 0.49 between the general average mean PK scores of 0.98 and NCE (N=37, Mean=9.78 SD=8.337); a very small amount of mean difference of 0.40 between the general average mean of 0.98 and B.Sc.Ed/B.Ed (N=56, Mean=8.89 SD=7.852) and a negligible amount of mean difference of 0.09 between the general average mean of 0.98 and B.Sc with PGDE (N=15, Mean=9.20 SD=8.809). The analysis showed that qualification of chemistry teachers does not affect their PK level on ICT in Gusau and Talata Mafara Educational Zones of Zamfara state. Although the mean difference

between teacher qualifications and level of PK on ICT was very small, it is important to test the corresponding null hypothesis to determine the statistical significance or otherwise of the mean difference obtained.

**Research question 3:** What is the difference between male and female chemistry teachers' pedagogical knowledge on ICT

**Table 3** Summary of mean and standard deviation of chemistry teachers PK on ICT in Gusau and Talata Mafara educational zones base on Gender.

Gender	N	Mean	Std. Dev.	Mean Difference
Male	76	8.39	7.185	2.86
Female	32	11.25	9.742	
<b>Total</b>	<b>108</b>			

*Field work (2023)*

**Table 4:** Summary of ANOVA analysis for Mean Difference Between Chemistry Teachers' Qualifications and PK on ICT in Gusau and Talata Mafara Educational Zones.

Sources of variation	SS	Df	MS	F-Cal	p-Value	Decision
Between groups	17.713	2	8.857	0.133	0.875	Ho <sub>1</sub>
Within groups	6980.027	105	66.476			Accepted
<b>Total</b>	<b>6997.741</b>	<b>107</b>	<b>75.333</b>			

*Field work (2023)*

Table 4 is the summary of ANOVA statistics conducted to determine the effect of Qualifications on PK on ICT among chemistry teachers in Gusau and Talata Mafara Educational Zones of Zamfara state. The analysis revealed that there was no statistically significant effect of qualification on the level of PK on ICT among chemistry teachers ( $F(2, 105) = 0.133$ ;  $p = 0.875$ ). Therefore since the p-Value of 0.133 is statistically greater than 0.05 level of significance. The null hypothesis one which states that "Chemistry teachers' qualification has no significant effects on their pedagogical knowledge on ICT" is accepted. Hence Educational qualification of chemistry teachers has no tangible effect on their PK on ICT in Gusau and Talata Mafara Educational Zones of Zamfara state.

**Ho<sub>2</sub>** There is no significant difference between male and female chemistry teachers' pedagogical knowledge on ICT

**Table 5:** Summary of Independent t-test statistics for the effect of Gender on PK on ICT among Chemistry Teachers in Gusau and Talata Mafara Educational Zones, Zamfara state.

Gender	N	Mean	SD	Df	t-Cal	p-Value	Decision
Male	76	8.39	7.185	106	-1.690	0.094	Ho <sub>1</sub> Accepted
Female	32	11.25	9.742				
<b>Total</b>	<b>108</b>						

*Field work (2023)*

Table 5 is the summary of independent t-test statistics conducted to determine the effect of Gender on PK on ICT among chemistry teachers in Gusau and Talata Mafara Educational Zones of Zamfara state. The analysis revealed that there was no statistically significant effect of Gender on the level of PK on ICT among chemistry teachers ( $t(106) = -1.690$ ;  $p = 0.094$ ). The analysis further revealed that there was insignificant amount of mean difference of 2.86 between the PK on ICT of Female (N=32, Mean=11.25, SD=9.742) and that of Male (N=76, Mean = 8.39, SD = 7.185) in favor of the female chemistry teachers. Therefore since the p-Value of 0.094 is statistically greater than 0.05 level of

Table 3 is the summary of descriptive statistics of Mean and Standard Deviation conducted to determine the difference between male and female chemistry teachers' PK on ICT in Gusau and Talata Mafara Educational Zones. The analysis revealed that there was a small amount of mean difference of 2.86 between the PK scores of male (N=76, Mean=8.39 SD=7.185) and that of female (N=32, Mean=11.25 SD=9.742). The analysis revealed that the female chemistry teachers performed better than their male counterparts but the difference was small. Hence this suggested that gender does not affect chemistry teachers' PK on ICT in Gusau and Talata Mafara Educational Zone. However, since there was small amount of mean difference between male and female teachers' PK on ICT level in favor of the female teachers, a corresponding null hypothesis was tested to determine the significance of the statistical difference obtained.

**Null Hypothesis Testing**

**Ho<sub>1</sub>:** Chemistry teachers' qualification has no significant effects on their pedagogical knowledge on ICT

significance. The null hypothesis one which states that "There is no significant difference between male and female chemistry teachers' pedagogical knowledge on ICT" is accepted. Hence gender of chemistry teachers has no significant effect on their PK on ICT in Gusau and Talata Mafara Educational Zones of Zamfara state.

## Discussion of findings

The main focus of this study is to investigate the chemistry teachers' pedagogical knowledge on ICT in Gusau and Talata Mafara educational zones of Zamfara state. The findings of the study revealed that most chemistry teachers in Gusau and Talata Mafara educational zones have low PK on ICT. The findings of

this study also revealed that there is no significant difference between male and female chemistry teachers' pedagogical knowledge on ICT and the teachers' qualification has no any effect on their PK level on ICT.

This findings is in line with the findings of Oluwagbohunmi, (2013) that the educators lack necessary skills and literacy for utilizing the ICT tools to enhance teaching-learning process. And the findings of Obielodan, et al., (2020) who found out teachers had low pedagogical knowledge on the use of ICT for teaching. And the findings of Enu, et al., (2018) who also found teachers hardly use technology in their lessons because of not having ICT integration skills. And Mailiza and Fan, (2020) who found out secondary mathematics teachers have a largely inadequate knowledge of ICT and knowledge of ICT usage in teaching. And also the findings of Newhouse (2002) that most teachers irrespective of the level of education have minimal ICT literacy. However, the study is in disagreement with the findings of (Igboegwu, Egolum, & Nnoli, 2011) which says that male teachers have higher knowledge on ICT than their female counterparts.

## Conclusion

In this study, the researchers investigated on the chemistry teachers' pedagogical content knowledge on ICT in Gusau and Talata Mafara educational zones of Zamfara state. It can be concluded that most chemistry teachers within Gusau and Talata Mafara educational zones have low PK on ICT. And the findings of the study also revealed that teachers' gender and qualifications has no any significant effect on their pedagogical knowledge on ICT.

## Recommendations

Based on the findings of this study, the following recommendations are made:

1. There is need for government policy on full integration of ICT into the teaching and learning.
2. Government and stakeholders in the field of education should organize a training, seminars, conference and workshops in order to boost the chemistry teachers' PK on ICT.
3. Government and other stakeholders in the field of education should make ICT facilities available to school to use for instructional purposes.
4. Government should also endeavor to equip all secondary school teachers with laptop and other ICT materials to enhance their teaching in the classroom. It is expected that this will help in boosting the standard of education in Zamfara state.

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