https://doi.org/10.68071/956hd8wb

ORIGINAL RESEARCH
Kakanchi Multidisciplinary Journal of COEASU
Vol. 1, Issue 1, 1-08, July 2026
OPEN ACCESS
E-ISSN 3156-397X

Digital Tools Integration and Chemistry Teaching in Some Secondary Schools in Kogi Central Senatorial District, Nigeria

Ahmed Nafiu Onoruoiza, Yakubu Rufai, & Abubakar Abdulhafiz Adeiza

Department of Chemistry, Federal College of Education (FCE) Okene, Kogi State, NIGERIA

Corespondance: *yakubu.rufai1852@fceokene.edu.ng*

Highlights:

Discovered that the chemistry teachers in Kogi Central have access to presentation software and messaging platforms.

Teacher perceptions for frequenct use of digital tool integration in chemistry teaching is low.

Founds an inadequate ICT infrastructure, Chemistry-specific professional development for teachers.and unreliable electricity are major barriers to digital tool use.

Received date: 7 May 2026
Revised date: 13 June 2026
Accepted date: 20 July 2026

Citation:Ahmed N. O., Yakubu R., & Abubakar A. A. (2026). Digital Tools Integration and Chemistry Teaching in Some Secondary Schools in Kogi Central Senatorial District, Nigeria.1(01), 1-08.

Abstract: This study assessed digital tools integration in Chemistry teaching in secondary schools in Kogi Central Senatorial District, Nigeria. Three research questions guided the study. A descriptive survey design was adopted. The population comprised 63 Chemistry teachers in 42 public senior secondary schools across the five Local Government Areas of Kogi Central. All 63 teachers were used as the sample through census sampling. Data were collected using the Digital Tools Integration Questionnaire (DTIQ), a 35-item instrument validated by three experts. Reliability was established through a pilot study in Kogi West Senatorial District, yielding a Cronbach's alpha coefficient of 0.82. Data were analysed using mean and standard deviation, with a criterion mean of 2.50 for decision-making (Nunnally & Bernstein, 1994). Findings revealed that presentation software (mean = 3.12) and messaging platforms (mean = 3.08) were the most available digital tools, yet overall frequency of use was low (grand mean = 2.41). Teachers held positive perceptions of digital tools (grand mean = 2.98) but faced significant challenges including inadequate ICT infrastructure (mean = 3.62) and unreliable electricity (mean = 3.54). No significant difference in integration was found between experienced and less experienced teachers, t (54) = 1.31, p = .20. The study recommended, among others, that the Kogi State Ministry of Education should prioritise ICT infrastructure provision, including functional computer laboratories and solar-powered electricity, and implement a structured, Chemistry-specific professional development programme for teachers.

Keywords: digital tools, Chemistry teaching, secondary schools

Introduction

The rapid advancement of information and communication technology (ICT) has transformed educational practices globally (Adegbenro & Gumbo, 2015). In Chemistry education, digital tools such as simulation software, virtual laboratories, interactive whiteboards, and mobile learning applications offer new possibilities for making abstract scientific concepts more accessible and engaging (Akpan & Onweh, 2020). Chemistry, as a subject dealing with phenomena at the molecular and atomic levels, particularly benefits from digital visualisation tools that can represent structures and reactions in ways traditional methods cannot (Gambari et al., 2016). Despite these recognised benefits, the integration of digital tools in Chemistry teaching remains inconsistent, particularly in developing countries where infrastructural and institutional barriers persist. In Nigeria, the Federal Ministry of Education (2019) has articulated a national ICT in Education Policy that envisions the integration of digital technologies across all levels of the education system. However, the gap between policy aspirations and classroom realities remains wide,

https://doi.org/10.68071/956hd8wb

particularly in rural and semi-urban areas where infrastructure deficits, erratic electricity supply, and limited teacher training constrain meaningful technology adoption (Yusuf & Afolabi, 2021). Existing studies on digital tools in Nigerian science classrooms have primarily focused on urban centres or state-wide surveys (Gambari et al., 2016; Nwosu & Ikwuka, 2023). There is limited research examining the specific realities of Chemistry teaching at the senatorial district level, where local infrastructure, socio-economic factors, and institutional support structures may differ markedly from state-wide averages. This study addresses these gaps by providing a focused, district-level examination of digital tools integration in Chemistry teaching within Kogi Central Senatorial District. Specifically, the study sought to:

1. determine the digital tools available for teaching Chemistry and their frequency of use in secondary schools in Kogi Central Senatorial District;
2. assess Chemistry teachers' perceptions of the benefits of and challenges to digital tools integration in the study area; and
3. determine whether a significant difference exists in digital tools integration between experienced and less experienced Chemistry teachers.

Based on these objectives, the following research questions were formulated:

1. What digital tools are available and how frequently are they used for teaching Chemistry in secondary schools in Kogi Central Senatorial District?
2. What are Chemistry teachers' perceptions of the benefits of and challenges to digital tools integration in the study area?
3. Is there a significant difference in digital tools integration between experienced and less experienced Chemistry teachers in Kogi Central?

Conceptual Framework

This study is anchored on a conceptual model positing digital tools integration in Chemistry teaching as a function of three interdependent factors: availability, teacher capacity, and institutional support. Availability refers to the physical presence and accessibility of hardware, software, and connectivity within the school environment. Teacher capacity encompasses the knowledge, skills, and attitudes necessary to deploy digital tools for pedagogical purposes. Institutional support includes policy frameworks, funding, technical assistance, and professional development opportunities provided by educational authorities. These three factors do not operate in isolation; rather, they interact such that deficits in any one dimension can undermine integration efforts regardless of strengths in the others.

Several studies have examined digital tools integration in Nigerian science education. Gambari et al. (2016) investigated the effectiveness of computer-assisted instruction on secondary school students' achievement in science subjects in Niger State, using a quasi-experimental design with 120 students. They found that students taught with computer simulations performed significantly better than those taught through conventional methods. Oloruntegbe and Alam (2022) conducted a state-wide survey of science teachers' ICT competencies in Ondo State, finding that while 78% of teachers expressed positive attitudes towards technology, only 34% reported regular use of digital tools in their classrooms. Infrastructure deficits and lack of training were identified as the primary barriers.Yusuf and Afolabi (2021) surveyed 200 secondary school teachers across three states in North-Central Nigeria and reported that digital tool availability was generally low, with only projectors and personal laptops being commonly accessible. Virtual laboratories and subject-specific software

were virtually absent. Akpan and Onweh (2020) specifically examined Chemistry teachers' readiness for technology integration in Akwa Ibom State and found that while teachers demonstrated adequate content and pedagogical knowledge, their technological knowledge was below the threshold for effective TPACK integration. Nwosu and Ikwuka (2023) reached similar conclusions in their study of science teachers in Enugu State. A recurring gap in the literature is the absence of district-level analysis that accounts for local variations in infrastructure, socio-economic conditions, and institutional support - a gap the present study fills.

Theoretical Framework

This study draws on two complementary theoretical frameworks: the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) and Rogers' (2003) Diffusion of Innovations theory. The TPACK framework extends Shulman's (1986) pedagogical content knowledge construct by adding technology as a distinct knowledge domain. It proposes that effective technology integration requires teachers to possess and integrate three knowledge bases: content knowledge, pedagogical knowledge, and technological knowledge. Applied to this study, TPACK suggests that Chemistry teachers in Kogi Central require more than mere access to digital tools; they need the integrated knowledge to select appropriate tools for specific Chemistry topics and to deploy them in pedagogically sound ways. The Diffusion of Innovations theory complements TPACK by explaining how new technologies spread through a social system over time, highlighting the roles of relative advantage, compatibility, complexity, trialability, and observability in the adoption process.

Methodology. This study adopted a descriptive survey design to address the three research questions concerning the availability and frequency of use of digital tools, teachers' perceptions of benefits and challenges, and experience-based differences in digital tools integration. The population of the study comprised all 63 Chemistry teachers across the 42 public senior secondary schools in the five Local Government Areas that constitute Kogi Central: Okene (10 schools), Adavi (10 schools), Ajaokuta (9 schools), Okehi (10 schools), and Ogori-Magongo (3 schools), based on published data from the Kogi State Ministry of Education Annual School Census (Kogi State Ministry of Education, 2018). Given the manageable size of the population, all 63 Chemistry teachers were used as the sample through census sampling.

Data were collected using the Digital Tools Integration Questionnaire (DTIQ), a researcher-designed instrument comprising 35 items organised into four sections: demographic information (4 items), availability of digital tools (10 items), frequency of use and perceived benefits (16 items), and challenges affecting integration (5 items). The instrument was validated by three experts — two from Chemistry Education and one from Educational Technology — at the Federal College of Education, Okene. Reliability was established through a pilot study involving 15 Chemistry teachers from Kogi West Senatorial District, which shares similar socio-economic and infrastructural characteristics with Kogi Central but was excluded from the main study. Cronbach's alpha computed from the pilot data was 0.82, indicating acceptable internal consistency (Nunnally & Bernstein, 1994). Data collection was conducted over a four-week period in March 2025. Of the 63 questionnaires distributed, 56 were duly completed and returned, representing a response rate of 88.9%. Data were analysed using mean and standard deviation to answer the research questions, with a criterion mean of 2.50 for decision-making.

https://doi.org/10.68071/956hd8wb

An independent samples t-test was used to examine experience-based differences, with teaching experience (ten or more years versus fewer than ten years) as the grouping variable.

Results

Research Question 1: What digital tools are available and how frequently are they used for teaching Chemistry in secondary schools in Kogi Central Senatorial District?

Table 1: Presents the Mean Ratings of the Availability and Frequency of use of Digital Tools.
Mean Ratings of Availability and Frequency of Use of Digital Tools for Teaching Chemistry (N = 56)

S/N	Digital Tool	Avail. Mean	Avail. SD	Freq. Mean	Freq. SD
1	Presentation software (PowerPoint, Google Slides)	3.12	0.74	2.59	0.88
2	Messaging platforms (WhatsApp, Telegram)	3.08	0.81	2.86	0.81
3	Educational YouTube videos	2.71	0.89	2.31	0.89
4	Personal laptop or tablet for instruction	2.66	0.94	3.07	0.72
5	Projector	2.45	0.95	1.33	0.55
6	Interactive whiteboard	1.93	0.83	1.33	0.55
7	Online assessment tools (Google Forms, Kahoot)	1.88	0.79	1.96	0.78
8	Chemistry simulation software (PhET, Crocodile)	1.80	0.76	1.73	0.70
9	Virtual laboratory software	1.65	0.72	1.42	0.61
10	Dedicated school computer laboratory for Chemistry	1.52	0.68	—	—
	Grand Mean	2.88	0.81	2.41	0.74

Note. Criterion mean = 2.50. Availability: Mean ≥ 2.50 = Available; < 2.50 = Not Available. Frequency: Mean ≥ 2.50 = High; < 2.50 = Low.

Table 2 presents the mean ratings of perceived benefits and challenges.
Mean Ratings of Perceived Benefits and Challenges of Digital Tools Integration (N = 56)

S/N	Item	Mean	SD	Remark
	Benefits			
1	Digital tools make abstract Chemistry concepts easier to explain	3.31	0.62	Agree
2	Digital tools increase student engagement in Chemistry lessons	3.16	0.67	Agree
3	Digital tools help students visualise molecular structures and reactions	3.08	0.74	Agree
4	Digital tools allow access to up-to-date Chemistry content	2.94	0.78	Agree
5	Digital tools improve students' performance in Chemistry	2.82	0.83	Agree
6	Digital tools enable differentiated instruction in Chemistry	2.73	0.81	Agree
7	Digital tools facilitate collaborative learning in Chemistry	2.67	0.88	Agree
8	Digital tools reduce time spent on repetitive instructional tasks	2.34	0.91	Disagree
	Grand Mean (Benefits)	2.98	0.78	Agree
	Challenges			
9	Inadequate ICT infrastructure in schools	3.62	0.54	Agree
10	Unreliable electricity supply	3.54	0.58	Agree
11	Insufficient professional development on digital tools	3.38	0.64	Agree
12	High cost of digital devices and educational software	3.29	0.71	Agree
13	Lack of technical support personnel within schools	3.18	0.76	Agree
	Grand Mean (Challenges)	3.40	0.65	Agree

Note. Criterion mean = 2.50. Mean ≥ 2.50 = Agree; < 2.50 = Disagree.

As shown in Table 1, four digital tools were available for teaching Chemistry (grand mean = 2.88). Presentation software (mean = 3.12, SD = 0.74) and messaging platforms (mean = 3.08, SD = 0.81) were the most available. However, overall

https://doi.org/10.68071/956hd8wb

frequency of use was low (grand mean = 2.41). The most frequently used tools were personal laptops (mean = 3.07, SD = 0.72) and messaging platforms (mean = 2.86, SD = 0.81). Virtual laboratory software (mean = 1.42) and interactive whiteboards (mean = 1.33) ranked lowest on both dimensions.

Research Question 2: What are Chemistry teachers' perceptions of the benefits of and challenges to digital tools integration in the study area?

Table 2 shows that Chemistry teachers generally perceived digital tools as beneficial (grand mean = 2.98), with the highest-rated items being that digital tools make abstract concepts easier to explain (mean = 3.31, SD = 0.62) and increase student engagement (mean = 3.16, SD = 0.67). However, all five challenges were rated as significant barriers (grand mean = 3.40), led by inadequate ICT infrastructure (mean = 3.62, SD = 0.54) and unreliable electricity supply (mean = 3.54, SD = 0.58).

Research Question 3: Is there a significant difference in digital tools integration between experienced and less experienced Chemistry teachers?

An independent samples t-test compared integration scores between experienced (≥ 10 years) and less experienced (< 10 years) teachers. Table 3 presents the results.

Table 3: *Independent Samples t-Test on Digital Tools Integration by Teaching Experience*

Group	n	Mean	SD	t	df	p
Experienced (≥ 10 years)	31	2.47	0.54	1.31	54	0.20
Less Experienced (< 10 years)	25	2.32	0.48			

Note. N = 56. Equal variances assumed (Levene's test: F = 0.87, p = .35). p > .05, not statistically significant.

As presented in Table 3, experienced teachers recorded a slightly higher mean integration score (mean = 2.47, SD = 0.54) than less experienced teachers (mean = 2.32, SD = 0.48). However, the independent samples t-test revealed no statistically significant difference, t(54) = 1.31, p = .20. Teaching experience alone does not significantly influence digital tools integration among Chemistry teachers in Kogi Central.

Discussion(s)

The finding that presentation software and messaging platforms were the most available digital tools, while virtual laboratories and simulation software were largely absent, is consistent with previous research in similar Nigerian educational contexts. Yusuf and Afolabi (2021) reported comparable patterns across North-Central Nigeria, where basic productivity tools were more accessible than subject-specific educational software. The low overall frequency of use (grand mean = 2.41) despite moderate availability of some tools confirms that availability alone does not translate into classroom integration. This finding aligns with the TPACK framework (Mishra & Koehler, 2006), which posits that effective technology integration requires more than access — it demands the convergence of technological, pedagogical, and content knowledge.

The contrast between teachers' positive perceptions of digital tools (grand mean = 2.98) and the severe challenges they face (grand mean = 3.40) highlights a critical implementation gap. Teachers recognise the pedagogical value of digital tools — particularly for making abstract Chemistry concepts more accessible — yet are constrained by systemic barriers. Inadequate infrastructure (mean = 3.62) and unreliable electricity (mean = 3.54) represent fundamental obstacles that no amount of teacher training can overcome. Oloruntegbe and Alam (2022) identified similar infrastructure deficits in Ondo State, and Yusuf and Afolabi (2021) documented

https://doi.org/10.68071/956hd8wb

the same pattern across North-Central Nigeria, suggesting these challenges are pervasive in Nigeria's public secondary school system rather than unique to Kogi Central. The non-significant difference between experienced and less experienced teachers ($t = 1.31$, $p = .20$) is noteworthy. It challenges the assumption that greater teaching experience naturally leads to greater technology integration. Akpan and Onweh (2020) reported a similar finding in Akwa Ibom State, and Nwosu and Ikwuka (2023) reached the same conclusion in Enugu State. These consistent findings across multiple Nigerian contexts reinforce the argument that generic teaching experience is an inadequate proxy for TPACK development. Deliberate, Chemistry-specific technology professional development is needed rather than reliance on years of service.

Conclusion

The findings lead to the conclusion that while Chemistry teachers in Kogi Central Senatorial District possess positive attitudes towards digital tools and have access to basic productivity technologies, the integration of subject-specific digital tools in Chemistry teaching remains limited due to systemic infrastructure barriers. The gap between the availability of generic tools and their actual classroom use, combined with acute deficits in specialised Chemistry software and hardware, indicates that infrastructure and professional development interventions are prerequisites for meaningful digital integration. Teaching experience alone does not confer digital integration competence, underscoring the need for targeted, Chemistry-specific professional development.

Recommendations

Based on the findings, the following recommendations were made:

1. The Kogi State Ministry of Education should prioritise the provision of basic ICT infrastructure, including functional computer laboratories, projectors, and reliable electricity supply through solar-powered alternatives, to secondary schools in Kogi Central Senatorial District.

2. The Federal College of Education, Okene, in partnership with the Kogi State Ministry of Education, should design and implement a structured, Chemistry-specific in-service professional development programme focused on building teachers' TPACK.

3. School administrators should establish partnerships with telecommunications providers and educational technology organisations to secure subsidised internet connectivity and digital resources for Chemistry classrooms.

4. The National Commission for Colleges of Education should strengthen the educational technology component of the Nigeria Certificate in Education curriculum to ensure pre-service Chemistry teachers graduate with practical digital integration skills.

5. Further research should employ experimental designs to evaluate the effectiveness of specific professional development interventions on Chemistry teachers' digital integration practices in Kogi Central.

Acknowledgements: The authors acknowledge the institutional support provided by Federal College of Education (FCE) Okene. The research infrastructure and academic environment facilitated the successful execution and completion of this study.

Funding Statement: This work was supported by personal effort.

Data Availability: The analyzed data are included within the article.

Declaration: The authors declare no potential conflicts of interest, financial or otherwise, that could be perceived as influencing the objectivity or integrity of the research presented herein.

Author Contributions: Ahmed, Nafiu Onoruoiza did the Conceptualization & Investigation. **Yakubu, Rufai** did the Formal Analysis, Methodology, and Validation, **Abubakar, Abdulhafiz Adeiza** support Funding Acquisition, Resources, and Project Administration. **Ahmed, Nafiu Onoruoiza** did the Writing of the original Draft, Writing-Review & Edit.

Disclosure: The AI-assisted visual output has been verified, with the authors taking final responsibility for the intellectual content.

References

Adegbenro, J. B., & Gumbo, M. T. (2015). Exploring the relationship between teachers' ICT competence and the use of ICT in teaching in South African secondary schools. *International Journal of Educational Sciences, 10*(1), 75–84. https://doi.org/10.1080/09751122.2015.11890342

Akpan, I. F., & Onweh, V. E. (2020). Chemistry teachers' readiness for technology integration in secondary schools in Akwa Ibom State, Nigeria. *Journal of Science Education and Technology, 29*(4), 512–524. https://doi.org/10.1007/s10956-020-09835-5

Federal Ministry of Education. (2019). *National policy on information and communication technologies in education.* Federal Government of Nigeria.

Gambari, A. I., Shittu, A. T., & Taiwo, O. A. (2016). Enhancing students' achievement in science through the use of computer-assisted instruction in Niger State, Nigeria. *Malaysian Online Journal of Educational Technology, 4*(2), 53–65.

Kogi State Ministry of Education. (2018). *Annual school census report 2017/2018: Senior secondary schools.* Department of Planning, Research and Statistics.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Nwosu, J. C., & Ikwuka, O. I. (2023). Science teachers' technology integration competencies in Enugu State secondary schools: Implications for Chemistry education. *Nigerian Educational Research and Development Council Journal, 18*(2), 142–158.

Oloruntegbe, K. O., & Alam, G. M. (2022). Science teachers' ICT competencies and classroom integration practices in Ondo State, Nigeria. *Education and Information Technologies, 27*(5), 6321–6340. https://doi.org/10.1007/s10639-021-10842-5

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14. https://doi.org/10.3102/0013189X015002004

Yusuf, M. O., & Afolabi, F. O. (2021). Digital technology integration in secondary schools in North-Central Nigeria: Teachers' perspectives and

https://doi.org/10.68071/956hd8wb

practices. *International Journal of Education and Development Using ICT, 17*(3), 45–62.