

Knowledge and Use of ICT-Demonstration Teaching Strategies among Senior Secondary School Science Teachers in Delta State, Nigeria

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Abstract

This study investigated the knowledge and use of Information and Communication Technology (ICT)-demonstration teaching strategies among senior secondary school Biology, Chemistry, and Physics teachers in Delta State, Nigeria. Four research questions and two null hypotheses guided the study. The descriptive survey design was adopted. From a population of approximately 1,250 science teachers, a multi-stage sampling procedure drew 320 teachers from 60 schools across 12 Local Government Areas. Data were collected using the researcher-developed ICT-Demonstration Teaching Strategies Questionnaire (ICTDTSQ), a four-point instrument validated by three experts and yielding Cronbach Alpha coefficients from 0.84 to 0.88, with an overall value of 0.87. Research questions were answered using mean and standard deviation, and the hypotheses were tested at the 0.05 level of significance using One-Way Analysis of Variance (ANOVA) and Pearson Product Moment Correlation. The findings were that science teachers possessed high knowledge of both ICT and ICT-demonstration teaching strategies, though this knowledge was concentrated in basic tools; that they rarely used ICT-demonstration strategies while often using general ICT strategies; that their use of ICT-demonstration strategies differed significantly by subject, with Physics teachers using them significantly less than Biology and Chemistry teachers; and that there was a significant positive relationship between teachers' knowledge of these strategies and their use of them. It was concluded that although science teachers in Delta State have acquired foundational knowledge of ICT-demonstration strategies, a marked gap exists between their knowledge and their classroom use of these strategies. Recommendations included the provision of ICT infrastructure and targeted, subject-specific professional development.

Keywords: ICT-Demonstration Teaching Strategies, ICT Integration, Science Education, Teacher Knowledge, Technological Pedagogical Content Knowledge, Delta State.

Introduction

Science education is widely regarded as a foundation for national development, equipping learners with the knowledge, skills, and dispositions required for participation in a technologically driven society. In Nigeria, the teaching and learning of Biology, Chemistry, and Physics at the senior secondary level is central to preparing students for careers in medicine, engineering, agriculture, and allied fields, and the National Policy on Education accordingly emphasises functional science instruction (Federal Republic of Nigeria, 2013). Despite these aspirations, students' performance in science subjects has remained a source of concern, and the strategies teachers adopt in the classroom have been repeatedly implicated in this pattern (Ogegbo, 2024; Onyeka & Okoye, 2023).

Two instructional approaches have attracted sustained attention as means of strengthening science teaching. The first is the demonstration method, in which the teacher shows learners how to carry out a procedure, manipulate apparatus, or observe a phenomenon while explaining the underlying principles. Demonstration is valued in science because it concretises abstract ideas, models correct laboratory technique, and makes visible processes that would otherwise be too costly, hazardous, or time-consuming for learners to perform individually (Onyeka & Okoye, 2023; Ekpo, Utibe, & Udofia, 2024). The second is the integration of Information and Communication Technology (ICT) into instruction. ICT refers to the diverse set of digital tools and resources used to create, store, process, and communicate information, and in the science classroom it encompasses computers, multimedia projectors, interactive whiteboards, educational software, simulations, virtual laboratories, and online resources (Olojo, Adewumi, Olojuolawe, & Ibukun, 2021; Alade, Adejumo, & Oyeyemi, 2021).

The ICT-demonstration teaching strategy represents the deliberate integration of these two approaches, using digital technologies to support, enhance, or in some cases substitute for traditional demonstration. Examples include using computer simulations to demonstrate phenomena that cannot easily be shown physically, such as molecular interactions or planetary motion; presenting video recordings of demonstrations that would be dangerous or expensive to conduct live; annotating demonstrations on interactive whiteboards; and using virtual laboratories to model experimental procedures before learners perform them. Nigerian and international studies report that such technology-enhanced demonstrations can improve conceptual understanding, attitude, and achievement in science relative to conventional instruction (Fabeku & Enyeasi, 2024; Oyeniran & Oteyolai, 2023; Pamisa & Hinacay, 2025).

The effective use of ICT-demonstration strategies, however, depends on more than the availability of equipment. It requires that teachers possess the knowledge to combine technology with sound pedagogy and subject content, a requirement captured by the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). A recurring theme in the literature is a gap between teachers' knowledge or favourable disposition toward ICT and their actual classroom use of it. Studies across Nigeria and beyond have found that science teachers frequently hold positive perceptions of ICT yet rarely use it in practice, citing inadequate infrastructure, limited access, unreliable electricity, insufficient training, and weak technological pedagogical content knowledge (Ogegbo, 2024; Ibrahimi, Miri, & Koçiaj, 2024; Ode & Torkula, 2024). Understanding both what teachers know and what they actually do is therefore essential if the promise of ICT-demonstration strategies is to be realised.

In Delta State, science teaching faces additional constraints, including shortages of qualified teachers, inadequate laboratory facilities, and uneven access to ICT infrastructure, and recent evidence indicates that although both teachers and students hold positive attitudes toward technology, existing facilities remain underutilised and teacher training remains a critical gap (Emovavwerhe & Peretomode, 2023; Atubi, 2022). Yet there is limited empirical evidence on the extent to which science teachers in the state possess knowledge of ICT-demonstration teaching strategies and actually use them in Biology, Chemistry, and Physics classrooms. This study addresses that gap by examining teachers' knowledge and use of both general ICT teaching strategies and integrated ICT-demonstration strategies, with a view to informing professional development, curriculum reform, and policy.

Statement of the Problem

Students' performance in senior secondary school science in Nigeria has remained persistently modest. In Biology, for example, the proportion of candidates obtaining credit passes (A1 to C6) in the West African Senior School Certificate Examination fluctuated around the middle range across recent years, at approximately 55.6 per cent in 2017, 55.1 per cent in 2018, 55.6 per cent in 2019, 53.0 per cent

in 2020, 50.9 per cent in 2021, and 57.4 per cent in 2022 (National Bureau of Statistics, 2023). This uneven performance has been linked less to the difficulty of the content than to the continued dominance of teacher-centred methods that leave learners passive and provide little practical or visual engagement with scientific ideas (Onyeka & Okoye, 2023; Ogebo, 2024).

In response, stakeholders have advocated instructional approaches that combine practical demonstration with modern ICT tools. While a body of research has established the effectiveness of demonstration methods and of ICT-based instruction taken separately (Ekpo et al., 2024; Fabeku & Enyeasi, 2024; Oyeniran & Oteyolai, 2023), far less is known about the integrated ICT-demonstration approach, and in particular about what science teachers know of it and whether they use it. The available evidence points to a troubling pattern in which teachers possess favourable attitudes or foundational competence but do not translate these into classroom practice, owing to infrastructural, institutional, and knowledge-related barriers (Ogebo, 2024; Alade et al., 2021; Ode & Torkula, 2024; Ibrahim et al., 2024).

This pattern has not been examined systematically among Biology, Chemistry, and Physics teachers in Delta State, where local studies confirm both positive dispositions toward technology and marked underutilisation of the facilities that exist (Emovavwerhe & Peretomode, 2023). The problem of this study, stated as a question, is therefore: what knowledge of ICT-demonstration teaching strategies do senior secondary school science teachers in Delta State possess, and to what extent do they use these strategies in teaching Biology, Chemistry, and Physics? Addressing this question is important because the integration of ICT with demonstration represents a potentially powerful yet under-examined response to the resource constraints and instructional weaknesses facing science education in the state.

Purpose of the Study

The main purpose of this study was to investigate the knowledge and use of ICT-demonstration teaching strategies among senior secondary school science teachers of Biology, Chemistry, and Physics in Delta State, Nigeria. Specifically, the study sought to:

1. determine the knowledge of ICT-demonstration teaching strategies possessed by science teachers for teaching Biology, Chemistry, and Physics;
2. determine the knowledge of general ICT teaching strategies possessed by science teachers at the senior secondary level;
3. ascertain the extent to which science teachers use ICT-demonstration teaching strategies in teaching Biology, Chemistry, and Physics;
4. ascertain the extent to which science teachers use general ICT teaching strategies at the senior secondary level;
5. determine whether there is a significant difference in the use of ICT-demonstration teaching strategies among Biology, Chemistry, and Physics teachers; and
6. determine whether there is a significant relationship between science teachers' knowledge of ICT-demonstration teaching strategies and their use of these strategies.

Research Questions

The following research questions guided the study:

1. What knowledge of ICT-demonstration teaching strategies do science teachers possess for teaching Biology, Chemistry, and Physics?
2. What knowledge of general ICT teaching strategies do science teachers possess at the senior secondary level?
3. To what extent do science teachers use ICT-demonstration teaching strategies in teaching Biology, Chemistry, and Physics?
4. To what extent do science teachers use general ICT teaching strategies at the senior secondary level?

Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

H₀₁: There is no significant difference in the use of ICT-demonstration teaching strategies among Biology, Chemistry, and Physics teachers in senior secondary schools in Delta State.

Ho2: There is no significant relationship between teachers' knowledge of ICT-demonstration teaching strategies and their use of these strategies in teaching science in senior secondary schools in Delta State.

Significance of the Study

The findings of this study are expected to be of significant value to science teachers, curriculum developers, policymakers, school administrators, students, and researchers. For science teachers, the study provides insight into their current knowledge and use of ICT-demonstration teaching strategies, thereby highlighting areas where professional development may be needed, and may motivate teachers to explore innovative ways of integrating ICT with demonstration methods. For curriculum developers such as the NERDC, the study provides empirical evidence that can inform the revision of the science curriculum to incorporate ICT-demonstration strategies more explicitly, and may guide the development of instructional resources and teacher guides.

For policymakers such as the Delta State Ministry of Education and the Federal Ministry of Education, the study provides data on the current state of ICT-demonstration teaching practices in schools, which can inform decisions regarding teacher training, infrastructure development, and resource allocation. For school administrators, the study highlights the importance of providing ICT resources and supporting teachers' use of innovative strategies. For students, the study may ultimately contribute to improved science learning outcomes by promoting the adoption of more effective teaching strategies. For researchers, the study contributes to the existing body of literature on ICT integration and demonstration methods in science education, providing a foundation for further research.

Scope and Delimitation of the Study

This study was delimited to senior secondary school science teachers of Biology, Chemistry, and Physics in Delta State, Nigeria. Geographically, the study focused on selected senior secondary schools across the three senatorial districts of Delta State, namely Delta North, Delta South, and Delta Central. The content scope was limited to the investigation of teachers' knowledge and use of ICT teaching strategies and ICT-demonstration integrated strategies in teaching science.

Review of Related Literature

Empirical Studies on ICT Teaching Strategies for Teaching Science

A consistent finding in the Nigerian literature is that the knowledge and competence of science teachers in ICT are uneven, with strength in the basic tools and weakness in the more advanced applications. Ode and Torkula (2024) surveyed 352 science teachers in Benue State and reported that teachers in public primary and secondary schools had low competency in ICT operations and utilisation, and that the competency differed significantly on the basis of school level and gender. In the same vein, Alade, Adejumo, and Oyeyemi (2021) studied 322 science teachers in Anambra State using a four-point scale with a criterion mean of 2.50, and found that the teachers held a positive attitude towards computer integration where resources were available but that they nonetheless lacked the competence to integrate computer technology into the teaching of science, and that the attitude and competence did not differ significantly on the basis of gender, age, or location. According to Agommuoh, Iroha, and Sunday (2021), who assessed the training and usage of ICT among senior secondary school teachers in Abia State, the training that teachers receive in ICT is related to the extent to which they use it in teaching science. These studies show that a favourable disposition, and even prior training, do not by themselves guarantee competent integration in the classroom, and this is in line with the position of the TPACK framework that meaningful integration requires a distinct and well-developed form of knowledge (Mishra & Koehler, 2006).

This emphasis on the knowledge of the teacher as a determinant of the quality of instruction has been sustained in earlier studies. According to Ijeh (2013), the pedagogical content knowledge that mathematics teachers possess and demonstrate during classroom practice shapes the quality of the instruction that the learners receive. In a related study, Ijeh, Akpomede, Njoseh, Igabari, and Enakpoya (2025) found that the mathematical knowledge of teachers for teaching was significantly related to the achievement, retention, and attitude of students in mathematics. Ijeh (2014) further documented the place of ICT in classroom practice and practicals, and underscored the growing expectation that the science and mathematics teacher should integrate technology into instruction.

Studies on the availability and use of ICT present a picture of limited infrastructure and correspondingly limited use. Ogegbo (2024), in a qualitative case study of six science teachers in Lagos, found that the teachers held positive perceptions of the usefulness of ICT but rarely used these technologies in their classrooms, and attributed the low use to limited technological resources and access to devices, unreliable electricity supply, weak technological pedagogical content knowledge, and lack of support and funding. According to Olojo, Adewumi, Olojuolawe, and Ibukun (2021), who surveyed science teachers across the three senatorial districts of Ondo State and analysed the data using Pearson correlation, where ICT is used in teaching, both the teacher and the students perform more efficiently. In Delta State, Emovavwerhe and Peretomode (2023) found that although teachers and students in the post-COVID-19 era held a positive attitude towards technology integration, the available facilities were insufficient and underutilised, and the training of teachers in web platforms, e-learning, and related tools remained a critical gap. This finding is in agreement with Atubi (2022), who reported that ICT resources supported instruction in Delta State classrooms where they were available. Ajala, Oyedepo, Oyewusi, and Daudu (2026) also observed that poor infrastructure and inadequate technological facilities continue to constrain the effective use of technology in science education in Nigeria.

This pattern is not confined to Nigeria. According to Ibrahim, Miri, and Koçiaj (2024), who studied science teachers in Albania, the use of ICT was limited by inadequate infrastructure, limited access to technology, and insufficient training of teachers, although there were indications of growing adoption following the COVID-19 pandemic. In the same way, Pamisa and Hinacay (2025) reported in a study in the Philippines that the ICT integration of teachers in science was high at the emerging and applying stages but low at the infusing and transforming stages, and that the integration was significantly and positively correlated with the learning outcomes of the pupils. These findings are in line with the Nigerian evidence and point to a common gap between disposition or basic use on the one hand and deeper, transformative integration on the other hand. It is evident from the foregoing studies that, although science teachers generally possess a favourable disposition towards ICT teaching strategies, their actual use of these strategies in the classroom remains limited, and comparatively little attention has been given to the knowledge that teachers possess as distinct from their general attitudes. The present study addresses this gap.

Empirical Studies on Demonstration Teaching Strategies for Teaching Science

Research on the demonstration method consistently reports gains in achievement relative to conventional instruction. Onyeka and Okoye (2023) found that the demonstration method significantly improved the achievement of students, and this finding is in agreement with Okotubu (2020), who reported gains in both achievement and retention in technical colleges in Delta State. In practical Physics, Ekpo, Utibe, and Udofia (2024) found that the demonstration method, combined with enhanced lecture and attention to the care of equipment, improved the achievement of students. When the demonstration method is enhanced with technology, the evidence is similarly positive. According to Fabeku and Enyeasi (2024), computer simulation and video media instructional packages improved the learning outcomes of Chemistry students, while Oyeniran and Oteyolai (2023) reported that computer-based simulations and video instructional packages improved the attitude and achievement of senior secondary school Physics students. Studies on the interactive whiteboard point in the same direction. Enwere and Chijioke (2026) reported a positive relationship between smart interactive board usage and the academic motivation of students in South-East Nigeria, and Ibrahim, Abubakar, and Jumare (2023) appraised the availability and efficacy of the interactive whiteboard for instruction. Taken together, these studies suggest that the integration of ICT with the demonstration method can strengthen science learning, provided that the teacher possesses the knowledge and the enabling conditions to use the tools.

It is evident from these studies that the demonstration method, whether used in its conventional form or enhanced with technology, improves the achievement, retention, attitude, and motivation of students in science. However, most of the reviewed studies treated the demonstration method and ICT separately rather than examining their integration, and few of them examined the differences among Biology, Chemistry, and Physics teachers or the relationship between the knowledge that teachers possess and their actual use of ICT-demonstration strategies. In addition, evidence specific to Delta State remains scarce. The present study was therefore designed to fill these gaps.

Methodology

Research Design

The study adopted the descriptive survey research design, which is appropriate for describing the characteristics, conditions, or practices of a population as they exist, without manipulation of variables (Nworgu, 2015). The design suited the study because the aim was to describe science teachers' knowledge and use of ICT-demonstration teaching strategies and to test hypotheses concerning differences and relationships among the study variables (Creswell & Creswell, 2018).

Population of the Study

The population comprised all senior secondary school science teachers of Biology, Chemistry, and Physics in public secondary schools across the three senatorial districts of Delta State, namely Delta North, Delta South, and Delta Central, estimated at approximately 1,250 teachers. Public secondary schools were chosen because they share common administrative structures, curriculum requirements, and resource conditions, which allows meaningful comparison of instructional practice.

Sample and Sampling Technique

A multi-stage sampling procedure was used. In the first stage, four Local Government Areas were selected from each of the three senatorial districts using simple random sampling, giving 12 Local Government Areas. In the second stage, five public senior secondary schools were randomly selected from each Local Government Area, giving 60 schools. In the third stage, the available Biology, Chemistry, and Physics teachers in each selected school were included through purposive sampling to ensure that teachers of all three subjects were represented. The minimum sample size was determined using the Yamane (1967) formula at a 0.05 margin of error, which yielded approximately 303; to allow for non-response, 350 questionnaires were distributed and 320 usable questionnaires were returned, a return rate of 91.4 per cent.

Research Instrument

Data were collected using a researcher-developed questionnaire, the ICT-Demonstration Teaching Strategies Questionnaire (ICTDTSQ). It comprised five sections. Section A collected demographic information (subject taught, gender, years of experience, highest qualification, and school location). Section B contained 10 items on knowledge of general ICT teaching strategies, and Section C contained 10 items on knowledge of ICT-demonstration strategies, both responded to on a four-point scale of Very High Knowledge (4), High Knowledge (3), Low Knowledge (2), and Very Low Knowledge (1). Section D contained 10 items on the use of general ICT teaching strategies, and Section E contained 10 items on the use of ICT-demonstration strategies, both responded to on a four-point scale of Very Often (4), Often (3), Rarely (2), and Never (1).

Validity and Reliability of The Instrument

The face and content validity of the instrument were established by three experts, two from the Department of Science Education and one from the Department of Measurement and Evaluation, all of Delta State University, Abraka, whose recommendations informed the rewording and revision of several items. Reliability was established through a pilot test with 30 science teachers in a state outside the study area, and internal consistency was computed with the Cronbach Alpha method. The subscales yielded coefficients of 0.86 (knowledge of ICT strategies), 0.84 (knowledge of ICT-demonstration strategies), 0.88 (use of ICT strategies), and 0.85 (use of ICT-demonstration strategies), with an overall coefficient of 0.87, all exceeding the 0.70 threshold and indicating that the instrument was reliable.

Method of Data Collection

The researcher obtained an introductory letter from the Department of Science Education, Delta State University, Abraka, which was presented to the principals of the selected schools. The letter explained the purpose of the study and sought permission to administer the questionnaire to science teachers. The questionnaires were administered personally by the researcher, assisted by trained research assistants, which ensured a high response rate and allowed for the clarification of any ambiguities. Teachers were given approximately 20 to 30 minutes to complete the questionnaire, and the completed questionnaires were collected immediately. Participation was voluntary and informed consent was obtained; anonymity and confidentiality were ensured by not requiring respondents to provide identifying information, and data were reported in aggregate form only.

Method of Data Analysis

The data collected were analysed using both descriptive and inferential statistics with the aid of the Statistical Package for the Social Sciences (SPSS) version 26. Research Questions 1 to 4 were

answered using mean and standard deviation computed from the four-point scale. The decision rule for interpreting the item mean scores was based on the real limits of the four-point scale, as follows: 3.50 to 4.00, Very High Knowledge or Very Often Used; 2.50 to 3.49, High Knowledge or Often Used; 1.50 to 2.49, Low Knowledge or Rarely Used; and 1.00 to 1.49, Very Low Knowledge or Never Used. Accordingly, a mean score of 2.50 and above was taken to indicate High Knowledge or Often Used, while a mean score below 2.50 indicated Low Knowledge or Rarely Used.

For the test of hypotheses, Hypothesis 1 was tested using One-Way Analysis of Variance (ANOVA), which is appropriate for testing differences among three or more independent groups, in this case Biology, Chemistry, and Physics teachers, on a continuous dependent variable, namely the use of ICT-demonstration teaching strategies measured as the mean of the ten items. Where a significant F-ratio was obtained, the Tukey Honestly Significant Difference (HSD) post-hoc test was applied to locate the source of the difference. Hypothesis 2 was tested using the Pearson Product Moment Correlation Coefficient, which is appropriate for examining the relationship between two continuous variables, namely teachers' knowledge of ICT-demonstration teaching strategies and their use of these strategies. In all cases, the null hypothesis was rejected where the p-value was less than 0.05.

Results

A total of 350 questionnaires were distributed, of which 320 were completed and returned, representing a 91.4 per cent return rate. The results are presented according to the research questions and hypotheses.

Demographic Characteristics of Respondents

Table 1: Demographic Characteristics of Respondents (N = 320)

Variable	Category	Frequency	Percentage (%)
Subject Taught	Biology	118	36.9
	Chemistry	104	32.5
	Physics	98	30.6
Gender	Male	158	49.4
	Female	162	50.6
Years of Experience	1 to 5 years	86	26.9
	6 to 10 years	94	29.4
	11 to 15 years	78	24.4
	16 years and above	62	19.4
Highest Qualification	NCE	42	13.1
	B.Sc./B.Ed.	186	58.1
	M.Sc./M.Ed.	82	25.6
	Ph.D.	10	3.1
School Location	Urban	168	52.5
	Rural	152	47.5

Table 1 shows that the sample comprised 118 Biology (36.9%), 104 Chemistry (32.5%), and 98 Physics (30.6%) teachers, with a near-even gender distribution (49.4% male, 50.6% female). The majority had ten years of experience or less, most held a first degree (58.1%) or a master's degree (25.6%), and the sample was drawn from both urban (52.5%) and rural (47.5%) schools.

Research Question 1: Knowledge of ICT-Demonstration Teaching Strategies

Table 2: Mean and Standard Deviation of Teachers' Knowledge of ICT-Demonstration Teaching Strategies (N = 320)

S/N	Item Statement	Mean	SD	Decision
1	Using video demonstrations to teach science concepts	2.68	0.82	High Knowledge

S/N	Item Statement	Mean	SD	Decision
2	Using computer simulations to demonstrate scientific phenomena	2.45	0.91	Low Knowledge
3	Using multimedia presentations to illustrate scientific procedures	2.72	0.78	High Knowledge
4	Using virtual laboratories to demonstrate experiments	2.18	0.95	Low Knowledge
5	Using online demonstration videos (e.g. YouTube)	2.85	0.74	High Knowledge
6	Using interactive whiteboards to annotate demonstrations	2.32	1.02	Low Knowledge
7	Using animation software to illustrate abstract concepts	2.15	0.98	Low Knowledge
8	Using digital microscopes to demonstrate specimens	2.28	1.05	Low Knowledge
9	Using presentation slides with embedded videos	3.12	0.69	High Knowledge
10	Combining physical demonstration with digital recording	2.55	0.88	High Knowledge
	Grand Mean	2.53	0.72	High Knowledge

Table 2 shows a grand mean of 2.53 (SD = 0.72), indicating that teachers possessed high knowledge of ICT-demonstration strategies overall. Knowledge was highest for accessible tools such as presentation slides with embedded videos (2.85 to 3.12) and lowest for advanced tools such as animation software, virtual laboratories, and digital microscopes (2.15 to 2.28).

Research Question 2: Knowledge of General ICT Teaching Strategies

Table 3: Mean and Standard Deviation of Teachers' Knowledge of General ICT Teaching Strategies (N = 320)

S/N	Item Statement	Mean	SD	Decision
1	Using computer simulations to teach science concepts	2.38	0.89	Low Knowledge
2	Using educational software for science instruction	2.56	0.84	High Knowledge
3	Using multimedia projectors to display lesson content	3.25	0.65	High Knowledge
4	Using online resources to prepare science lessons	2.92	0.78	High Knowledge
5	Using virtual laboratories for science experiments	2.12	0.96	Low Knowledge
6	Using educational videos to supplement instruction	2.88	0.75	High Knowledge
7	Using interactive whiteboards for science teaching	2.25	1.04	Low Knowledge
8	Using mobile applications for science learning	2.48	0.92	Low Knowledge
9	Using internet search engines for scientific information	3.35	0.58	High Knowledge
10	Using presentation software for lessons	3.42	0.55	High Knowledge
	Grand Mean	2.76	0.68	High Knowledge

Table 3 shows a grand mean of 2.76 (SD = 0.68), indicating high knowledge of general ICT strategies overall. As with ICT-demonstration strategies, knowledge was concentrated in basic tools such as presentation software and internet search (3.35 to 3.42) and was low for virtual laboratories, interactive whiteboards, and computer simulations (2.12 to 2.38).

Research Question 3: Use of ICT-Demonstration Teaching Strategies

Table 4: Mean and Standard Deviation of Teachers' Use of ICT-Demonstration Teaching Strategies (N = 320)

S/N	Item Statement	Mean	SD	Decision
1	I use video demonstrations to teach science concepts	2.42	0.88	Rarely Used
2	I use computer simulations to demonstrate phenomena	2.08	0.94	Rarely Used

3	I use multimedia presentations to illustrate procedures	2.58	0.82	Often Used
4	I use virtual laboratories to demonstrate experiments	1.85	0.89	Rarely Used
5	I use online demonstration videos (e.g. YouTube)	2.72	0.79	Often Used
6	I use interactive whiteboards to annotate demonstrations	1.95	0.97	Rarely Used
7	I use animation software to illustrate abstract concepts	1.78	0.88	Rarely Used
8	I use digital microscopes to demonstrate specimens	1.92	0.94	Rarely Used
9	I use presentation slides with embedded videos	2.95	0.71	Often Used
10	I combine physical demonstration with digital recording	2.28	0.91	Rarely Used
	Grand Mean	2.25	0.74	Rarely Used

Table 4 shows a grand mean of 2.25 (SD = 0.74), indicating that ICT-demonstration strategies were rarely used overall. Only presentation slides with embedded videos, online demonstration videos, and multimedia presentations reached the Often Used band; advanced tools were rarely used.

Research Question 4: Use of General ICT Teaching Strategies

Table 5: Mean and Standard Deviation of Teachers' Use of General ICT Teaching Strategies (N = 320)

S/N	Item Statement	Mean	SD	Decision
1	I use computer simulations to teach science concepts	2.15	0.92	Rarely Used
2	I use educational software for science instruction	2.35	0.86	Rarely Used
3	I use multimedia projectors to display lesson content	3.05	0.72	Often Used
4	I use online resources to prepare science lessons	2.82	0.78	Often Used
5	I use virtual laboratories for science experiments	1.78	0.88	Rarely Used
6	I use educational videos to supplement instruction	2.65	0.82	Often Used
7	I use interactive whiteboards for science teaching	1.92	0.95	Rarely Used
8	I use mobile applications for science learning	2.22	0.91	Rarely Used
9	I use internet search engines for scientific information	3.28	0.62	Often Used
10	I use presentation software for lessons	3.35	0.58	Often Used
	Grand Mean	2.56	0.71	Often Used

Table 5 shows a grand mean of 2.56 (SD = 0.71), indicating that general ICT strategies were often used overall. Notably, the overall use of general ICT strategies (2.56) exceeded the overall use of ICT-demonstration strategies (2.25), suggesting that teachers are more comfortable using ICT for general instructional purposes than for demonstration-specific ones.

Hypothesis 1

H₀₁: There is no significant difference in the use of ICT-demonstration teaching strategies among Biology, Chemistry, and Physics teachers in senior secondary schools in Delta State.

Table 6: Mean and Standard Deviation of Use of ICT-Demonstration Strategies by Subject Taught

Subject	N	Mean	SD
Biology	118	2.44	0.71
Chemistry	104	2.26	0.73
Physics	98	2.02	0.72

Subject	N	Mean	SD
Total	320	2.25	0.74

Table 7: One-Way ANOVA for Difference in Use of ICT-Demonstration Strategies among Subject Teachers

Source of Variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	9.45	2	4.73	9.07	0.000
Within Groups	165.23	317	0.52		
Total	174.68	319			

Significant at $p < 0.05$.

Table 7 shows an F-ratio of 9.07 ($p = 0.000$). Since p is less than 0.05, the null hypothesis was rejected: there was a significant difference in the use of ICT-demonstration strategies among Biology, Chemistry, and Physics teachers. Table 6 indicates that Biology teachers used these strategies most (2.44) and Physics teachers least (2.02). The Tukey HSD post-hoc test located the source of the difference, as shown in Table 8.

Table 8: Tukey HSD Post-Hoc Comparison of Mean Differences in Use of ICT-Demonstration Strategies

Subject (I)	Subject (J)	Mean Difference (I - J)	Std. Error	p-value
Biology	Chemistry	0.18	0.10	0.164
Biology	Physics	0.42	0.10	0.000
Chemistry	Physics	0.24	0.10	0.049

Significant at $p < 0.05$. Mean differences are expressed on the four-point scale.

The post-hoc comparison showed that Physics teachers used ICT-demonstration strategies significantly less than both Biology teachers (mean difference = 0.42, $p = 0.000$) and Chemistry teachers (mean difference = 0.24, $p = 0.049$), while Biology and Chemistry teachers did not differ significantly (0.18, $p = 0.164$). The overall difference was therefore driven mainly by the comparatively low use among Physics teachers.

Hypothesis 2

Ho2: There is no significant relationship between teachers' knowledge of ICT-demonstration teaching strategies and their use of these strategies in teaching science in senior secondary schools in Delta State.

Table 9: Pearson Correlation between Knowledge and Use of ICT-Demonstration Strategies

Variable	N	r	p-value	Remark	Decision
Knowledge of ICT-Demonstration Strategies	320	0.68	0.000	Strong, positive	Reject Ho
Use of ICT-Demonstration Strategies	320				

Significant at $p < 0.05$.

Table 9 shows a Pearson correlation of 0.68 ($p = 0.000$) between teachers' knowledge and use of ICT-demonstration strategies. Since p is less than 0.05, the null hypothesis was rejected: there is a significant, strong, positive relationship between teachers' knowledge of these strategies and their use of them, indicating that teachers with greater knowledge tend to use the strategies more frequently.

Discussion of Result

The first finding of this study showed that science teachers possessed high overall knowledge of both ICT and ICT-demonstration strategies, and that this knowledge was concentrated in the basic

tools. This finding maybe due to the fact that the basic tools, such as presentation software, internet search engines, and online videos, are readily available on the personal devices of teachers and require little specialised training, whereas the advanced tools, such as virtual laboratories, animation software, and digital microscopes, demand dedicated infrastructure and sustained professional development. This finding is in agreement with Alade, Adejumo, and Oyeyemi (2021), who found that teachers were disposed towards computer integration where resources existed, and with Ode and Torkula (2024), who documented uneven competency across ICT operations. The finding also lends support to the TPACK framework of Mishra and Koehler (2006), which holds that the teacher develops the integrative knowledge required for the tools that are within reach but not for those that lie beyond the enabling conditions of the school.

The most important finding of this study is the gap that exists between knowledge and use. Although the teachers possessed high knowledge of ICT-demonstration strategies, with a grand mean of 2.53, they rarely used these strategies, with a grand mean of 2.25, and their use of general ICT strategies, though higher at 2.56, still mirrored the basic-tool pattern. This finding maybe due to the fact that the use of these strategies depends not only on what the teacher knows but also on the conditions that prevail in the school, such as the availability of functioning equipment, reliable electricity supply, technical support, and adequate time for lesson preparation. This finding is in agreement with Ogegbo (2024), who observed in Lagos that teachers held positive perceptions of ICT and yet rarely used it, and attributed the shortfall to limited resources, unreliable electricity, weak technological pedagogical content knowledge, and lack of support. It is also in line with the findings of Ibrahim, Miri, and Koçiaj (2024) in Albania, where infrastructure, access, and training constrained use, and with Pamisa and Hinacay (2025) in the Philippines, where integration was high at the basic stages but low at the transformative stages. In the same vein, Emovavwerhe and Peretomode (2023) documented in Delta State a positive attitude towards technology alongside underutilised facilities and gaps in teacher training. This shows that the closing of the gap requires attention to the enabling conditions, and not to knowledge alone.

The finding that there was a significant difference in the use of ICT-demonstration strategies among the subject teachers, with the Physics teachers using these strategies significantly less than the Biology and Chemistry teachers, is noteworthy. This finding maybe due to the fact that the content of Biology and Chemistry lends itself readily to visual and video-based demonstration of processes such as cell division, photosynthesis, and chemical reactions, whereas many of the concepts in Physics rest on mathematical representation and the manipulation of apparatus that are not as easily rendered through the basic digital tools available to the teacher. This finding is in agreement with Fabeku and Enyeasi (2024) and Oyeniran and Oteyolai (2023), whose studies suggest that the effectiveness and uptake of technology-enhanced demonstration vary with the type of content. Differences in access to relevant digital resources and in subject-specific professional development may also account for the difference, and the comparatively low use among the Physics teachers signals a particular need for targeted support in that subject.

Finally, the finding that there was a strong and positive relationship between the knowledge and use of ICT-demonstration strategies, with $r = 0.68$, lends support to the TPACK framework of Mishra and Koehler (2006). This finding is in agreement with Ijeh, Akpomede, Njoseh, Igabari, and Enakpoya (2025), who found that the professional knowledge of teachers is significantly related to instructional outcomes. The relationship shows that the development of the integrative knowledge of the teacher is a means of increasing the use of these strategies. It is important to note, however, that the use remained lower than the knowledge, and this indicates that knowledge is necessary but not sufficient, since infrastructural and institutional barriers also operate. Comprehensive strategies must therefore address both the development of knowledge and the provision of enabling conditions (Ogegbo, 2024; Emovavwerhe & Peretomode, 2023).

Conclusion

Senior secondary school science teachers in Delta State possess high knowledge of both general ICT and ICT-demonstration teaching strategies, but this knowledge is concentrated in basic, accessible tools, with low knowledge of advanced technologies such as virtual laboratories, animation software, digital microscopes, and interactive whiteboards. Despite this knowledge, teachers rarely use ICT-demonstration strategies, even though they often use basic ICT tools for general instruction. A marked

gap therefore exists between what teachers know and what they do, indicating that factors beyond knowledge, including infrastructure deficits, limited access, weak institutional support, and inadequate subject-specific training, inhibit classroom use. Use also varied by subject, with Physics teachers using these strategies least, and teachers' knowledge was strongly and positively related to their use. In sum, while science teachers in Delta State have acquired foundational knowledge of ICT-demonstration strategies, their capacity to integrate these strategies effectively into instruction remains limited, and closing the knowledge-use gap will require a combined investment in professional development, infrastructure, and institutional support.

Recommendations

Based on the findings, the following recommendations are made:

1. The Delta State Ministry of Education should prioritise the provision of ICT facilities, including computers, projectors, interactive whiteboards, and reliable internet and power, with particular attention to rural schools where infrastructure deficits are most acute.
2. Teacher education institutions should incorporate ICT-demonstration strategies into science education curricula, training teachers not only in basic ICT skills but also in advanced tools such as virtual laboratories, simulations, and animation software.
3. The Ministry of Education and school administrators should organise regular, subject-specific in-service training on ICT-demonstration integration, with dedicated support for Physics teachers, whose use of these strategies was lowest.
4. Science teachers should be encouraged and supported to convert their existing knowledge into practice through school-based technical support, mentoring, and professional learning communities, since knowledge alone did not translate into use.
5. The Nigerian Educational Research and Development Council should reflect ICT-demonstration strategies explicitly in the science curriculum and accompany them with instructional resources and teacher guides.

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