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EFFECTS OF INFORMATION TECHNOLOGY (IT) -INTEGRATED TEACHER DEMONSTRATION STRATEGY (ITD) ON SENIOR SECONDARY SCHOOL CHEMISTRY STUDENTS ACHIEVEMENT IN ENUGU SOUTH LOCAL GOVERNMENT AREA OF ENUGU

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Abstract: Chemistry students encounter difficulties learning the subject is confirmed by many studies and these learning difficulties have labelled some topics difficult. These learning difficulties may be attributed to the methods of teaching often employed by the teachers. It is against this background this study investigated the effectiveness of integrating Information Technology (IT) into commonly employed teaching method (Teacher Demonstration) on four students' learning outcomes in some difficult topics (Mole Concept, Chemical Kinetics, Electrolysis and Oxidation and Reduction Reactions) in senior secondary (SS) chemistry. The study involved 124 (63 male, 61 female) SS 2 chemistry students from 4 schools purposively selected from one Education Zone in Enugu State, Nigeria. Using a pre-test post-test non-equivalent control group quasi experimental research design, the study examined the main effects of the treatments, gender and the interaction effects of the variables on chemistry students' conceptual understanding, problem-solving skills, acquisition of science process skills and acquisition of 21st century skills. Four major instruments: Chemistry Conceptual Understanding Test (CCUT), Problem-solving Skills Test (PSST), Science Process Skills Test (SPST) and 21st Century Skills Test (21st CST) were used to collect data. Data were analysed using descriptive statistics and analysis of covariance (ANCOVA). Results showed that IT-integrated Teacher Demonstration was the most effective for all the learning outcomes. There were significant main effects of Lecture Method (LM), on chemistry students' achievement. There was no significant influence of gender on any of the learning outcome. Findings also revealed significant interaction effects of treatment (ITD and LM) on chemistry students' conceptual understanding, science process skills and 21st century skills. From the findings, integration of IT into these teaching strategies is highly recommended for teaching of chemistry in secondary schools for better academic achievement in chemistry.
Keyword: IT-INTEGRATED TEACHEAR DEMONSTRATION STRATEGY.

Introduction

Science is an organized body of knowledge that uses a systematic approach in exploring and investigating nature in a testable and verifiable manner in order to establish presumed relations among phenomena with the basic aim of improving our understanding of nature. Okeke (2021) has identified the major components that science should reflect and these are: information domain, process domain, creative domain, attitudinal domain and personal relevance domain. Science is one of the core components of the school curriculum and it includes separate subjects like Physics, Chemistry and Biology in secondary school. These are referred to as natural science. The learning of any science therefore, should emphasize the nature of science as a dynamic discipline in which inquiry is central. An inquiry-based learning approach is an activity-oriented that enables learners to explore the environment and use the process skills of observing, collecting, measuring, analyzing, predicting and interpreting to construct knowledge, reflect and apply the knowledge

Globally, science and technology are changing the world around us at an unbelievable rate. Any nation that ignores scientific and technological education may find it difficult to fit into the global advancement in science and technology. In the years past, learning in classrooms was a cycle of memorization, repetition and note copying but now, the world is increasingly shaped by Information and Communication Technology (ICT). Technology has become an integral part of everyday living at home and school, learners come in contact with the mobile phone, Ipad, television, computer, internet, games, automatic doors, security cameras, remote control, fax machines and many others. A conflict then arises when such students get to the classroom and are still expected to listen, write and regurgitate (Anamezi, Onah and Aniekwu, 2023). Thus, the 21st century classroom must be matched with the 21st century education which should be flexible, creative, challenging and complex.

The state of science teaching and learning in Nigeria is a concern to all. According to Ekabua, Ogini, and Ogwara (2019). Science teaching at various levels still retains the old conservative approach with the teacher, in most cases, acting as the repertoire of knowledge and the students as the passive recipients. In a conventional lecture-based teaching environment, students‘involvement is restricted as teachers usually employ teaching methods which focus on information delivery and knowledge acquisition rather than encourage the construction of knowledge within the social context. Most of the time, the conventional lecture is conducted through a one-way communication, with limited opportunities for class discussion and active student involvement. Studies confirmed that traditional science teaching still rely heavily on lectures, reading and teacher demonstrations in a typical Nigerian science classroom setting where expository and unproductive teaching methods are often observed (Ekabua, Ogini, and Ogwara (2019). These teaching strategies are said to be inadequate and inappropriate to attain conceptual learning and critical thinking. The predominant use of teacher-centered teaching methods in which the teacher acts as the custodian and dispenser of knowledge and students as receptors makes students passive listeners, taking notes from projected displays and from the lecturer‘s explanations (Ekabua, Ogini, and Ogwara (2019). Understanding the concept becomes difficult especially where the concept is not only complex, but also abstract and dynamic as in chemistry in particular.

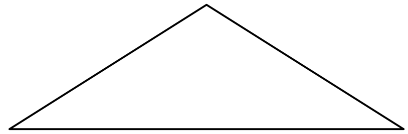
Adeoye (2016) reported that classroom interaction accounted for about 74% and 71% of variation in students‘cognitive achievement and process skills acquisition respectively. Kpolovie and Awusaku (2016) stressed that meaningful learning is possible in science if the students are given opportunities to operate equipment and materials that help them to construct knowledge of phenomena and related scientific concepts. Furthermore, Kpolovie, and Awusaku (2016) emphasized the importance of engaging science students in practical activities. Students are active participants and need to be engaged in the learning process. Chemistry, the science subject that deals with the composition, structures and properties of matter also deals with the interactions between different types of matter and the relationships between matter and energy. Through the learning of chemistry, it is possible to acquire relevant conceptual and procedural knowledge as well as develop understanding and appreciation of development in engineering, medicine and other related scientific and technological fields. Furthermore, learning about the contributions, issues and problems related to innovations in chemistry will help students to develop a holistic view of the relationships among science, technology and society. As numerous as the importance of chemistry are, students encounter difficulties learning the subject because of the abstract nature of the subject which has been confirmed by many authors (Obialor and Chukwuagu, 2022). In addition, conceptual and procedural difficulties are also associated with the subject (Omoniyi and Torru 2018).

Knowledge comprises ideas, facts, principles and theories possessed by an individual about an object or phenomenon that is obtained through experience. Conceptual knowledge is made up of the constructed, integrated and functional ideas, facts and principles in a subject area that is in the learner‘s cognitive structure. It may be achieved through instruction and by thoughtful and reflective mental activity that is devoid of any memorization. Knowledge that is mentally organized and meaningfully learnt facilitates appropriate retrieval and application in solving problems in a particular knowledge domain. Thus, learning with understanding (meaningful learning) is more powerful than memorization because such organization improves retention and facilitates learning of related materials (Onah and Achufusi, 2022). Taber (2001) argued that, unlike Physics and Biology, Chemistry does not allow for ease of constructing naïve meanings related to real world phenomena. Evidence abounds that learners have difficulties in learning the subject (WAEC 2015, 2017, 2021; Kpolovie and Awusaku (2016). Students have great difficulty understanding chemistry concepts at all levels of education (Berg 2012). This may be due to the ideas students bring to the study of chemistry which have been formed from their experience of the world and which differ from accepted scientific ideas (Kpolovie and Awusaku (2016). The performance in external examination is an indication that students have difficulty learning the subject.

Analysis of students‘ performance in Chemistry in WASCE from 2014 to 2017 showed that the performance of students in chemistry in most cases was less than 50% except in 2018, 2021 and 2024 where more than 50% credit pass was recorded which was inconsistent. This is an indication that students may have some learning difficulties in the subject. The candidates‘weaknesses identified by The Chief Examiners‘ were: ‚‚Poor level of communication skills, inadequate practical exposure, poor quantitative skills, inability to relate concepts in Chemistry to everyday life and lack of understanding of some Chemistry concepts"(WAEC, 2014 - 2017). This phenomenon has also been observed internationally (). Many reasons have been adduced for this poor performance in chemistry. According to Samba and Eriba (2012), it may be due to the abstract nature of chemistry concepts while Obialor and Chukwuagu, (2022) hinged it on student and teacher related factors. Part of the teacher related factors is the teaching methods employed by teachers to teach the concepts. Further analysis of the results showed that students find certain topics difficult to learn in Chemistry. Different authors (WAEC, 2014; 2017; 2019) have attributed the learning difficulties to the abstract nature of many Chemistry concepts, didactic methods of instruction, students ‘levels of conceptual understanding, mathematical abilities and problem solving skills among other factors that may be responsible for this poor performance.

Conceptual understanding in chemistry is the constant interplay between the macroscopic, microscopic and symbolic levels of thought and it is the act of understanding of the concepts that represents a significant challenge to the novice (Bradley & Brand, 1985). Three levels of understanding of concepts (the macroscopic, microscopic and symbolic levels) have been identified in education, particularly in learning chemistry (Anderson, 1990; Johnstone, 1993 and Gabel, 1993). The macroscopic level is a concrete level of understanding which corresponds to knowledge acquired through observing objects such as physical properties of an object and change in states of matter. The microscopic level is an abstract level but corresponding to observable phenomena at the macroscopic level. This level is characterised by concepts, theories and principles used to explain what is observed at the macroscopic level. Examples are movement of electrons, molecules or atoms. The symbolic level is used to represent macroscopic and microscopic phenomena by the use of chemical symbols, formulae, numbers, chemical equations, mathematical equations, graphs and representation of reaction mechanisms. For learning to be effective, the concepts ought to be understood meaningfully at all levels. Chemistry teachers and students are expected to operate across all the three levels of thought easily and move from one mode of thinking to the other (Obialor and Chukwuagu, 2022) placed these three levels at the vertices of a triangle and emphasised that every student studying chemistry for whatsoever purpose needs to operate within the triangle‖.

Descriptive (Macroscopic)



Microscopic (particulate)
Symbolic (Representational)

Figure 1.1: Levels of knowledge representation.

It has been are often limited among chemistry students because their understanding is confined to the surface features of a representation at the macroscopic level such as colour, density appearance and all physical properties (Oforma, and Archibong, 2021). Students therefore have difficulties in understanding concepts at the microscopic and symbolic levels and in integrating mentally across the three levels. In general, the difficulties that students at all levels of education encounter in understanding chemical concepts can be summarized as follows: inadequate conceptual knowledge, inability to interrelate the content representation at macroscopic, microscopic and symbolic levels as well as the unobservable particulate and mathematical nature of chemistry content (Oforma, and Archibong, 2021). However, the most prevalent studies on students ‘understanding in chemistry are on the identification of their misconceptions and correct conceptions on certain chemistry topics. There exists few studies on students‘understanding at the three levels of thought (macroscopic, microscopic and symbolic) either in relation to the students‘levels of thought (Hamari, Shernoff, Rowe and Coller (2016), Khan, Gul, Hussain and Yousaf, 2022; Onah, 2023), ability to solve quantitative problems (Kelly & Jones, 2008) and acquisition of skills or attitude to chemistry learning (Obialor and Chukwuagu, 2022). All these contributed to some topics being labelled as difficult. Literature abounds on the difficult topics and concepts in chemistry. For example, the most frequently reported difficult topics in Chemistry as revealed by WAEC Chief Examiners and in Science Education literature are Electrolysis, Redox Reactions, Chemical Kinetics and Chemical Equilibrium (Oladebinu, Amos, Amos, and Oyediran, (2018); WAEC, 2014; 2017; 2018; 2019). Other reported difficult topics and concepts include the Mole Concept (Kavak, and Yamak, (2016) and Organic Chemistry (Hamari, Shernoff, Rowe and Coller (2016), Khan, Gul, Hussain and Yousaf, 2022; Onah, and Anamezie 2022).

Lack of problem-solving skills is another factor responsible for the difficulty student's encounter in chemistry. The ability of students to solve numerical problems is not equivalent to conceptual understanding of molecular concepts. In addition, teaching students to solve problems is not equivalent to teaching concepts. Though students have conceptual difficulties, many of them are still able to solve quantitative problems related to the domain correctly. They do this by relying on algorithms especially for basic or routine problems (Ookman, 2016). It then becomes difficult for students to solve problems that are ill-defined and do not have a set of steps by which to move through the problem. Therefore, problem solving skills need to be developed in students as a result of learning. Research studies have shown that methods of teaching enhance the acquisition of problem-solving skills. Therefore, the teaching method employed by the teacher is an important factor to be considered. The use of teacher–centered methods of teaching which do not allow for students 'involvement has been attributed to be the major cause of students 'learning difficulties in chemistry Ookman (2016) referred to these methods of teaching where students are passive and which generate non-meaningful learning as ―Transmissive teaching‖. ―Transmissive teaching‖ leads to rote memorization of the knowledge acquired which is not truly assimilated by the students and does not translate into applicable skills. Obialor and Chukwuagu, (2022) argued that transmissive methods of teaching lack overall understanding of the contents; connections and comparisons are overlooked and the student struggles with discussing what he or she has learned in an order different from that which he/she has studied. In other words, knowledge is memorized but it is meaningless and does not translate into thought. This problem could be solved through appropriate teaching methods.

The new curricula in most countries often recommend to varying degrees, a transition from a teacher-centered classroom‖ to a student-centered learning environment. Science, by nature, is systematic, testable and its processes can be replicated and this justifies the fact that science should be taught by doing. The teacher should not spend a great deal of time telling students about science; instead students should be provided with opportunities to find out on their own. There is pure discovery learning approach where the learner is left to discover by himself without any assistance or guidance and where the learning is not structured. An alternative teaching approach for the development of intellectual skills and critical thinking is IT-integrated teaching demonstration involves the use of multimedia presentations, simulations, virtual labs and other IT-base resources to deliver chemistry lessons. The teaching method often employed in science teaching in Nigeria which though, teacher centered, yet may encourage inquiry to some extent, is the teacher-demonstration method. Instead of science teachers using the lecture method, most of them resort to teacher demonstration. The demonstration method is a teaching strategy that involves a demonstration being carried out by the teacher for students to observe/participate in or by the student for both the teacher and other students to observe/participate. Although, it emphasizes the demonstrator‘s activities and reduces those of the students at the same time yet demonstration is desirable and necessary where dangerous or complex procedures are involved, where apparatus is complicated and expensive and where equipment are limited. In using the method, the demonstrator may explain steps in an operation, techniques of handling a piece of apparatus or the procedure in carrying out an activity. The method, being activity-oriented, is executed with examples to enhance cognitive, affective and psychomotor domains of instructional objectives. Demonstration also appeals to the student's sense of sight and hearing and could be presented to the entire class, small group of students or to an individual student. According to Omeje (2024), the teacher can promote maximally the gains of demonstration method through conscious manipulation of classroom interactions. These classroom interactions include stating instructional objectives, planned repetition, active students ‘involvement, reinforcement and questioning. It is the effectiveness of manipulation of classroom interactions that helps the students to achieve more of the educational objectives. Omeje (2024) argued that the demonstration method can promote educational objectives as it can be applied at different levels of instructional objectives if well planned by the teacher. The major criticism against the teacher demonstration approach is that it does not usually involve students ‘active participation in the process because it is teacher-centered. The shift from teacher-centered teaching approach to students ‘active participation strategies has led to the inclusion of technology in the classroom like never before. Technology tools such as computers, mobile learning devices, software applications and video, audio, multimedia, and information communication technology are being integrated into the classrooms. The integration of such tools has contributed to efficiency and effectiveness of teaching and learning. The reasonable use of Information Technology (IT) makes scientific teaching methods more effective, flexible and multiple (Hamari, Shernoff, Rowe and Coller (2016), Khan, Gul, Hussain and Yousaf, 2022; Onah, 2023). The application of IT in the classroom enables teachers to stimulate students ‘learning and challenge their higher order thinking skills. Students are more of visual learners; therefore, appropriately designed software materials can help students build mental links to strengthen their logical framework of conceptual understanding and to achieve a mastery level in learning of chemical concepts. Mormah and Bassey (2019), proposed the integration of software as an effective teaching strategy to promote effective conceptual change in electrochemistry. Also, Melo, Liopis, Gasco, and Gonzalez, (2020) supported the fact that computer instructional package software improved senior secondary school students ‘performance in electrochemistry. However, it seems that the integration of ICT into classroom practice by chemistry teachers around the world is a bit slow and some barriers to integrating ICT use in the schools‘ curriculum have been identified (BECTA, 2004). Thus, it is against this background that the study seeks to determine the effects of IT-integrated teacher demonstration strategy on senior secondary school chemistry student's achievement in Enugu South Local Government Area of Enugu State.

Statement of the Problem

The importance of Chemistry in the society today cannot be over emphasized because of its relationship to other fields. The knowledge of the subject and its applications contribute immensely to industrial development of any nation. As numerous as the importance of chemistry, students encounter difficulties learning the subject especially at the secondary school level because of its abstract nature. These learning difficulties include consistent poor conceptual understanding and problem solving ability which might have been responsible for Nigerian students‘consistent poor performances in the subject in the external examinations conducted by the West African Examinations Council (WAEC) as well as the consistent poor conceptual understanding and inability to relate concepts in Chemistry to everyday life as reported by the Chief Examiners.

The observed students poor performance and weaknesses in chemistry in Nigeria is a strong indication of students‘poor conceptual knowledge and inadequate skills acquisition which might have been caused by the teaching methods often employed by the chemistry teachers. Teaching methods employed by chemistry teachers in Nigeria do not match with the needs of the 21st century learners, as they encourage rote memorization that leads to poor meaningful learning at the macroscopic level. Hence, students find some topics difficult to learn in chemistry.

Previous work done on integration of computer interactive instructional activities into the recommended teaching strategy were done in tertiary institutions not secondary schools, but on other subjects not chemistry or different locations not Enugu-South. Could the integration of IT into strategies of teaching improve students ‘performance and reduce learning difficulties in some chemistry difficult topics? In light of the above, this study aim at investigating if the teaching and learning of chemistry would be improved by integrating computer interactive instructional activities into the recommended teaching strategy –teacher demonstration method for teaching some of the difficult topics in chemistry. The study also sought to find the relative effectiveness of this teaching strategies on students ‘learning outcomes in chemistry among secondary schools students in Enugu South Local Government Area of Enugu State, Nigeria.

Purpose of the study

The main purpose of the study is to investigate the effect of Information Technology (IT) -Integrated teacher demonstration strategy (ITD) on senior secondary school chemistry students achievement in Enugu South Local Government Area of Enugu State on four chemistry students‘ learning outcomes (conceptual understanding and problem-solving skills) in four randomly selected difficult topics in senior secondary school chemistry among secondary school students in Enugu South Local government Area of Enugu State.

Specifically the study aims to:

1. Examine the effect of IT-Integrated teacher demonstration and lecture method strategy on students' Achievement (conceptual understanding and problem-solving skills) in four difficult chemistry topics.
2. Find out if gender has any effect on the students‘ learning outcomes in chemistry

Significance of the study

The findings of this study will be of immense benefits: - `

(i) To the chemistry teachers; the findings of the study would provide empirical evidence that integrating computer interactive instructional package into instructions would foster acquisition of scientific knowledge, skills and appropriate attitude towards the difficult topics and this may be extrapolated to the less difficult topics.

(ii) To the students; chemistry students would find great assistance in acquiring meaningful understanding of abstract chemical processes and concepts such as redox reactions, mole concept, electrolysis and many others in the IT-integrated strategies with learning activities that complement each other in simulations and animations as this may improve students ‘performance in external examinations.

(iii) The findings from this study would contribute to knowledge about teaching and learning strategies that use computer interactive packages in classroom environment to address teaching difficulties in abstract and difficult concepts in chemistry.

Scope of the Study

The study was delimited to ascertain the effects of IT-integrated teacher’s demonstration strategy on senior secondary schools chemistry students learning outcomes in Enugu South Local government Area in Enugu State. The concepts covered were four difficult topics in the senior secondary school chemistry curriculum: the mole concept, electrolysis, rates of chemical reactions and oxidation and reduction reactions (redox reaction). Only the public senior secondary schools in Enugu- South Local Government Area will be involved in the study.

Research Questions

1 What are the effects of treatments (IT-Integrated teacher demonstration strategy and Lecture Method) on students’ Achievement (conceptual understanding and problem solving skills) in chemistry?

2 What is the effect of gender on students ‘learning outcomes in chemistry?

Hypothesis

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

1 There is no significant main effect of treatment (IT-integrated Teacher Demonstration and Lecture Method strategies) on Achievement in chemistry.

2 There is no significant effect of gender on students ‘Achievement in chemistry.

Research Method

The study adopted quasi-experimental research design to determine the effectiveness of IT-integrated teacher demonstration on secondary school students‘ achievement on conceptual understanding (macroscopic, microscopic and symbolic levels), problem solving skills (prior knowledge, linkage and problem recognition skill), acquisition of five science process skills (observing, classifying, measuring, predicting and inferring) and five 21st century skills (ICT rating, communication, critical thinking, collaboration and leadership). There were also a control group taught with Lecture Strategy. So, in this study, there is one experimental conditions (IT-Integrated Teacher Demonstration (ITD) and one control conditions (Lecture Method (LM). Quasi-experimental research design is an experiment whereby participants cannot be randomly assigned to experimental and control groups. Specifically, the study used nonequivalent control group design. This design was employed because it was not possible to randomly assign participants to experimental and control groups. Classes that were already established (intact classes) were used for the study because randomization will disrupt the school activities. The population for the study was 1320 students, with a sample of one hundred and twenty four 124 (63 male, 61 female) Secondary School two chemistry students (SS 2) drawn from 4 co-educational secondary schools out of 45 secondary schools in Agbani Education zone. The selection of the sample was done in two stages using multi-stage sampling. In the first stage, one out of the three local government area in the zone was selected using random sampling by balloting. The second stage Involves selection of schools out of the Government owned schools in the chosen local Government area, a purposive sampling technique was used to select public secondary schools. Four research instruments were used for the collection of data. The four research instruments used are as follows: The Chemistry Conceptual Understanding Test (CCUT) and The Problem-Solving Skills Test (PSST) which was developed by the researcher and validated by three research experts. Two of the experts are from the Department of Science Education while one is from Measurement and Evaluation unit of the Department of Mathematics and Computer Education, all from Faculty of Education, Enugu State University of Science and Technology.

Test items of the instruments (CCUT and PSST) were first administered to 32 chemistry students of two single sex (male and female) Secondary Schools that were not involved in the sample for the study but have similar academic environment and background with the schools used for the study. The reliability of each of CCUT and PSST were determined using Pearson Moment Correlation Formula. The reliability values of 0.73 and 0.81 were obtained for CUT and PSST respectively. The researcher trained four (4) SS II chemistry teachers (on ITD) in the sampled schools on the use of the teaching packages to teach the selected topics for two weeks. Using the package, step by step operational guides on each of the topics in the experimental teaching strategy were followed to train the teachers. The researcher trained four (4) SS II chemistry teachers (on ITD) in the sampled schools on the use of the teaching packages to teach the selected topics for two weeks. Using the package, step by step operational guides on each of the topics in the experimental teaching strategy were followed to train the teachers. All the Chemistry students in their intact classes in the four (4) schools selected were pretested at the 4th week using the four instruments in the following order:

- CCUT: Chemistry Conceptual Understanding Test
- PSST: Problem-solving Skills Test

Pre-test was carried out to find out the initial differences between the groups. The test administration was conducted by the Chemistry teachers. Data collected were analysed using mean, standard deviation and Analysis of Co-variance (ANCOVA) where pre-test scores served as covariates so as to take care of the initial differences among the groups. Analysis of covariance (ANCOVA) was used in testing the hypotheses at .05 level of significance. The choice for the use of ANCOVA is because intact classes were used and initial differences cannot be guaranteed. The null hypothesis was rejected if probability value is less than or equal to the significant value of 0.05 ($P \leq 0.05$) and if otherwise ($P > 0.05$), it was not rejected.

Data Analysis and Results

Research Question 1: What are the effects of IT-Integrated teacher demonstration strategy on students' achievement (conceptual understanding; problem solving skills; acquisition of basic science process skills; and acquisition of 21st century skills) in chemistry?

The mean, mean difference and standard deviation of the treatment groups- IT-integrated Teacher Demonstration (ITD) strategy and Lecture Method (LM) Strategy groups on each of the learning outcomes were used to answer the question as shown on Table 4.1.

Table 4.1: Descriptive Statistics of pre and post-treatment Achievement scores based on treatment

Treatment	Learning Outcomes	Mean (pre-test)	Std Dev	Mean (Post-test)	Std Dev	Mean Difference
IT-Integrated	Conceptual	9.71		13.92	2.761	4.21
Teacher	Understanding	8.61	3.319	12.10	3.738	3.49
demonstration	Problem Solving	7.98		9.65	3.568	1 .67
(ITD)	Conceptual		3.856	10.94	3.974	2.22
Lecture Method	Understanding	8.72	3.478			
(LM)	Problem Solving		3.888			

Table 4.1 shows the mean, standard deviation and mean difference of the Achievement before and after the treatments. The higher the mean difference, the more effective the strategy.

The teaching strategy that was most effective for all Achievement test was IT-integrated Teacher demonstration (ITD) based on the mean difference as shown on Table 4.1. The values are 4.21, 3.49, 4.22, 4.35 for conceptual understanding, problem-solving, science process skills and 21st century skills acquisitions respectively. Each of the values was the highest among the two treatment groups. Further, conceptual understanding had the highest mean difference of 4.21 which means that IT-integrated Teacher demonstration (ITD) is most effective in teaching for conceptual understanding.

Observations based on learning outcomes showed that: the mean difference of the conceptual understanding scores of students taught by ITD strategy (4.21) was far higher than those taught by LM strategy (1.67).In problem-solving, the mean difference of students taught by ITD strategy (3.49) was higher than those taught by LM strategy (2.22).

Research Question 2: What is the effect of gender on students' Achievement in chemistry?

To answer the research question, Table 4.2 shows the mean differences of students Achievement by gender.

Table 4.2: Interaction Effect of Treatment and Gender on Achievement

Treatment	Learning Outcomes	Gender	Mean (x) Scores pre-test (x)	Std Dev SD	Mean (x) Scores Post-test (x)	Std Dev SD	Mean Difference
ITD	Conceptual Understanding	Male	10.4643	3.30820	15.8214	2.74430	5.3571
		Female	9.3450	3.34274	14.0426	2.80494	4.6976
LM		Male	8.7197	3.65283	12.0833	3.79722	3.3636
		Female	8.0879	3.79342	10.0023	3.94643	1.9144

ITD	Problem solving	Male	8.3750	3.78784	32.7321	2.37786	24.3571
LM	Skills	Female	7.8930	3.95757	29.8298	2.13988	21.9368
		Male	8.4507	2.85752	34.6742	2.78097	26.2235
		Female	7.0275	3.75703	32.2198	2.51318	25.1923

The interaction effect of treatment and gender is shown on Table 4.2 for the Achievement test. The mean differences show that male students performed better in all the teaching strategies. ITD is the most effective strategy for conceptual understanding and problem solving skills for both male and female chemistry students.

Hypothesis $H_0$1:

There is no significant main effect of treatment (IT-integrated Teacher Demonstration and Lecture Method strategies) on students ‘learning outcomes in chemistry.

To test for the significance of the differences, the hypothesis $H_0$1 was tested on each achievement tests

(i) Conceptual Understanding

To determine if the differences in post-test and pre-test scores of conceptual understanding are significant across the two groups, ANCOVA technique was employed. Post-test scores on conceptual understanding were entered as the dependent variable; experimental condition was entered as the independent factor, while the pre-test scores in conceptual understanding were entered as the covariates as presented on Table 4.3.

Table 4.3: Summary of Analysis of Covariance of treatment on conceptual understanding among chemistry students.

Source	Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5808.719[a]	4	363.045	187.088	.000	.875
Intercept	1812.807	1	1812.807	934.194	.000	.685
PRECUT (Covariates)	4135.260	1	4135.260	2131.024	.000	.832
TREATMENT	832.364	3	277.455	142.981	.000*	.500
Error	832.476	441	1.941			
Total	80489.000	446				

Corrected Total	6641.195	445

a. R Squared = .875 (Adjusted R Squared = .870)
b. * significant at 0.05
a. PRECUT = Pretest Conceptual Understanding

Table 4.3 shows that for treatment condition, the calculated F-value of 142.981 was significant at p<0.05 given degrees of freedom 3 and 441 ($F_{3, 441}$ = 142.981, p = 0.000). This means that there was a significant effect of treatment on conceptual understanding among chemistry students. Hence, the null hypothesis H_O1 is rejected for conceptual understanding.

Thus, there is a significant effect of the treatment on conceptual understanding of students in chemistry.

(ii) Problem solving Skills

Problem solving skills is another dependent variable in this study. To determine the significant effect of the treatment on problem solving skills across the four groups, ANCOVA technique was employed. Post-test scores on problem solving skills were entered as the dependent variable; experimental condition was entered as the independent factor, while the pre-test scores in problem solving skills were entered as the covariates. The results are shown in Table below;

Table 4.3.1: Summary of Analysis of Covariance of treatment on problem solving skills among chemistry students

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5808.719[a]	4	363.045	187.088	.000	.875
Intercept	1812.807	1	1812.807	934.194	.000	.685
PREPSST	5121.210	1	5121.210	5150.914	.000	.923
(Covariates)	564.290	3	188.097	189.188	.000*	.570
TREATMENT	832.476	441	1.941			
Error	80489.000	446				
Total	6641.195	445				
Corrected Total						

a. R Squared = .944 (Adjusted R Squared = .942) b. *significant at < 0.05 c. PREPSST = pretest problem solving skills test.

Table 4.3.1 shows that for treatment condition, the calculated F-value of 189.188 is significant at p< 0.05 given 3 and 441 degrees of freedom ($F_{(3, 441)}$ = 189.188, p = 0.000). Hence, the null hypothesis is rejected. This means that there is significant effect of the treatment on problem solving skills among chemistry students.

The partial eta squared of 0.570 accounts for 57% contribution of treatment to the effect. In other words, there is a significant difference in the post tests scores of students‘problem-solving skills in the two groups after treatment.

Thus, there is a significant effect of treatment on chemistry students‘problem-solving skills.

Hypothesis Ho2:

It states that there is no significant effect of gender on students‘learning outcomes in chemistry.

To ascertain the significant effect of gender null hypothesis 2 was tested on the achievement tests;

(i) Conceptual Understanding

Table 4.3.2. Showed the test of significance for conceptual understanding

Table 4.3.2: Summary of Analysis of Covariance of treatment and gender on conceptual understanding among chemistry students.

Source	Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5808.719[a]	16	363.045	187.088	.000	.875
Intercept	1812.807	1	1812.807	934.194	.000	.685
PRECUT (Covariates)	4135.260	1	4135.260	2131.024	.000	.832
TREATMENT	832.364	3	277.455	142.981	.000*	.500
Gender	.664	1	.664	.342	.559	.001
TREATMENT * Gender	3.863	3	1.288	.664	.575	.005
Error	832.476	429	1.941			
Total	80489.000	446				
Corrected Total	6641.195	445				

a. R Squared = .875 (Adjusted R Squared = .870) , b. * significant at 0.05 ,c.PRECUT = Pre-test on conceptual understanding test.

The test of significance on Table 4.3.4 shows no significant interaction between treatment and gender on conceptual understanding ($p > 0.05$). p = .575. The null hypothesis is therefore accepted for conceptual understanding.

(ii) Problem solving skills

Table 4.3.3. showed the test of significance for Problem solving skills

Table 4.3.3: Summary of Analysis of Covariance of treatment and Gender on problem solving skills among chemistry students

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7249.564[a]	16	453.098	455.726	.000	.944
Intercept	749.714	1	749.714	754.063	.000	.637
PREPSST (Covariates)	5121.210	1	5121.210	5150.914	.000	.923
TREATMENT	564.290	3	188.097	189.188	.000*	.570
Gender	.332	1	.332	.334	.563	.001
TREATMENT * Gender	1.415	3	.370	.474	.773	.003
Error	426.526	429	1.114			
Total	65766.000	446				
Corrected Total	7676.090	445				

a. R Squared = .944 (Adjusted R Squared = .942)
b. * significant = 0.05 (c) PREPSST = pretest problem solving skills test

Discussion of Findings

The findings of this study are discussed in line with the specific objectives.

The major findings are:

1. IT-integrated Teacher Demonstration strategy was the most effective for all the achievement test.
2. Comparing the information technology-integrated and non-information technology-integrated strategies, ITD was better than LM.
3. There was no significant influence of gender on any of the achievement.

Conclusions

The study established that Information Technology-integrated teacher demonstration teaching strategies were effective at improving senior secondary school students 'achievement in conceptual understanding and acquisition of problem-solving skills, science process skills and 21st century skills. The use of technology in classroom teaching motivated and encouraged students more than.

Recommendations

Based on the results obtained and discussed in this study, the following recommendations are hereby made:

(1) Integration of technology into regular classroom instruction is recommended to chemistry teachers for the teaching of Chemistry in Senior Secondary Schools for better academic achievement in Chemistry.

(2) The use of Information Technology-integrated teaching strategies is recommended for Chemistry teachers for better understanding of scientific concepts and skills acquisition to enhance meaningful learning.

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