MITIGATING THE CHALLENGES OF DIGITAL LITERACY IN EDUCATION THROUGH THE USE OF DIGITAL TEACHING TOOLS (DTT) IN FOSTERING STUDENTS' ACHIEVEMENT IN CHEMISTRY.

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Abstract
The study explored the efficacy of the use of Digital Teaching Tools (DTT) in fostering students' achievement in Chemistry in comparison with Lecture method. A non-equivalent, control group quasi-experimental design was used for the study. Data collected from 119 students was analyzed using mean, standard deviation and analysis of covariance. The result revealed that DTT resulted in higher achievement as opposed to lecture method ($F_{(1, 115)} = 86.769$, $p = .000$, $<.05$). Even though gender had significant effect on the achievement of male and female students in Chemistry ($F_{(1, 63)} = 5.966$, $p = 016$ $<.05$) with female students performing better than male. There was no significant interaction of gender and teaching approaches ($F_{(1, 115)} = 0.522$, $p = .472$, $>.05$). The findings imply that restructuring Chemistry teaching approaches to accommodate the use of DTT will enhance students' achievement. The researchers hereby recommend that teachers should inculcate DTT for improved achievement in Chemistry.

Keywords: *Academic achievement, Digital Teaching Tools (DTT), Chemistry.*

Introduction
Researchers have identified a lot of factors responsible for the poor achievement in Chemistry recorded over the years in the Senior Secondary School Examinations conducted by West African Examination Council (WAEC, 2025) and adduced them to include lack of adequate instructional materials (Omotola, 2018), lack of adequate laboratory activities (Usman,

2015), ineffective teaching methods employed in teaching of Chemistry by the teachers (Okechineke, 2025), lack of appropriate instructional strategy (Eze, Egbo & Okechineke, 2024), lack of competent Chemistry teachers as well as teacher's attitude (Rasha, 2017), qualification and teaching style (Pratoomtong, 2011) amongst others. Meanwhile, one of the major contributing factors to Chemistry students' academic achievement is the issues of instructional method adopted by Chemistry teachers as some may not be conversant with innovative strategies or approaches to teaching that can make the learning of Chemistry more meaningful to the students, thereby making their academic achievement in Chemistry to remain low (Okechineke, Eze & Nweze, 2025).

In schools and colleges, academic achievement refers to a student's ability to meet specific learning objectives, acquire knowledge, and demonstrate critical thinking, problem-solving abilities which also involves the development of essential soft skills, and self-discipline necessary for their future endeavours (Eze, 2024). The measure of the amount of knowledge/mastery derived from learning; the level of success attained in relation to a task that is carried out; and the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, represent their academic achievement, as well as the capacity to apply knowledge in practical contexts, as well as successfully complete coursework in subjects like Chemistry irrespective of their genders (Okechineke, 2025).

In Nigeria, the study of Chemistry cannot be downplayed at the secondary school as it precures many science-based professions and disciplines in the university like biochemistry, medicine, engineering, nursing, agriculture, science education, and so on; making it one of the frontline science subjects in both secondary schools, colleges and higher institutions, with branches like organic, inorganic, analytical, biochemistry, biophysical, physical chemistry, and so on. It has contributed to improved living conditions for mankind, production of food, drugs, building materials, textiles and modern transportation systems, and so on (Okechineke, et. al., 2025; Eze, et. al., 2024). Chemistry has high enrolment of students in its senior school certificate examination (SSCE) yearly in both the internal and external (WAEC, 2024). National Policy on Education (NPE) has major objectives of Chemistry to prepare the students to acquire adequate useful, meaningful

and relevant cognition of Chemistry skills for laboratory and field operations; to develop the ability of applying the acquired knowledge to their daily live activities, which is a reflection of the desired scientific attitudes, inculcated in them through learning; as well as apply the basic rudiments of Chemistry in their higher level of career and profession (Okechineke, et. al., 2024).

In recent decades, Nigeria policymakers have increasingly emphasized the importance of improving educational quality to meet the demands of the twenty-first century and rapid pace of technological advancement in transforming knowledge, skills, and competencies of learners.

Technology has been in used in the classroom since the nineteenth century. Initially devices such as the overhead projector were considered significant advances on more traditional technologies such as the chalkboard the pencil and the ball point pen (Anon, 2018). More recently, rapid advances in computing have revolutionized how technology is implemented to enable learning. With the advent of the Internet and smart devices, access to information is now easier than ever before (Siwawetkul & Koraneekij, 2018). For example, mobile phone technology has a 70% penetration and the majority of worldwide internet traffic is funneled through smartphones (Boxer, 2018). The ever-present nature of technology in our daily lives facilitates rapid information access and permits alternative approaches to technology enhanced teaching to be adopted during (synchronous) and outside (asynchronous) class contact time (Pricahyo, et. al., 2018).

Digital technological resources are powerful tools to support learning and the easy access to Information and communication technology which has transformed every aspect of human life particularly in teaching and learning (Liao et al, 2017). Digital technological in teaching is characterized with capacity to record, manage, represent, and communicate data and information. A substantial contribution of digital tools and technologies in teaching and learning processes, is that they create meaningful digital educational environments that in turn contribute to the creation of mental models and provide incentives for learner engagement. These tools are mainly used in teaching and learning to tackle impossible or extremely difficult issues in a different way, as opposed to paper or

laboratory work (Ezechukwu, 2024). Digital technological tools refer to electronic gadgets such as mobile phone, computers, smart boards, video machines, projector used with their applications and internet used for dissemination of information and for teaching and learning in schools (Obiweluozo, et. al., 2021). These resources, systems, devices generate, store, or process data in pictures, audio and video forms.

Digital teaching tools are resources that has transformed education by sustaining learners' interest in learning, motivating them to learn more, making them actively engaged in their learning and is effective in facilitating learning (Haleem et al, 2022). They commonly refer to a broad collection of technologies which capture, process, store and transmit information in digital form. Digital teaching tools can be both hardware-based devices such as computers, mobile devices like smart phones, game consoles, video and audio players, and software-based applications such as web applications, blogs, wikis, social-networking sites, and chat sites. Ezechukwu (2024) identifies video and image sharing, simulations, games, handheld and tablet computing, digital cameras, scanners, virtual environments, augmented reality and wearable technologies as emerging digital technologies available for use in education. Digital teaching tools are resources that engage and empower students, promote peer learning and creativity.

Ogunbodede and Oribhabor (2022) on digital resources usage and academic performance of undergraduate students found that digital resources do increase their research productivity, influences their performance in-class assignments, enhance their performance in seminar writing and presentation, as well as leads to increase in academic performance of students. Also, Ahmed (2019) on examining the influence of technological factors on student's academic performance found that there was a positive influence of use of applications technologies on students' academic performance such that the improvement was significantly greater in blended technology learning compared to traditional learning, and that without gender disparity. Kumi-Yeboah, et. al. (2020) explored the use of digital technologies in online learning environment and found out that use of digital technologies advanced their knowledge acquisition, helped them to engage, participate, and contribute to knowledge creation in the online discussion forums, provided them opportunities to participate in the

educational process and performed better in the online learning environment. On the other hand, Eden (2019) who studied digital tools utilization on Chemistry students' academic achievement discovered that students taught with digital tools performed better than those taught with expository method and that male students performed better than female students in the two groups, revealing significant gender difference and significant interaction effect of gender and strategies.

Since the integration of digital teaching tools in educational settings has become increasingly prevalent, offering promising opportunities to enhance the learning experience for students, little attention has been paid to its effect as it bothers on students' achievement in Chemistry especially in the schools in Ebonyi state where adequate and appropriate digital tools for teaching are yet to be made available.

Methodology

Quasi-experimental design, specifically the non-equivalent control group design was employed in this study while the area of this study was Ikwo Local Government Area of Ebonyi state. A sample size of 119 SS2 Chemistry students (37 boys and 82 girls) from four intact classes drawn using multi-stage process involving random sampling technique to get Abakaliki LGA from Ebonyi North Educational zone, purposive sampling technique to get co-educational schools as gender is a factor, random sampling to get intact classes and then random sampling to get the schools for experimental and control groups. Two classes were used for experimental (taught with DTT = 67) and two classes were used as control group (taught with LM = 52). The instruments developed for data collection in this study was a validated researcher self-developed Chemistry Achievement Test (CAT) with an internal consistency reliability coefficient of KR-20 = 0.65. All the research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05% level of significance.

Results

The results were presented in accordance with the research questions and hypotheses that guided the study.

Responses on mean achievement score of students taught Chemistry using digital teaching tools (DTT) and those with lecture method

For this research question, data obtained with the CAT for the treatment (DTT) and control (LM) groups were used to answer the research question. Summary of result of data analysis is presented in table 1.

Table 1: Summary of pre-test and post-test of mean and standard deviation for achievement scores of students taught Chemistry using DTT and those with LM

Method	n	Pre-test		Post-test		Gain Score
		Mean	SD	Mean	SD	
Experimental (DTT)	67	8.34	2.28	23.69	3.84	15.35
Control (LM)	52	8.48	2.81	16.96	3.89	8.48
Total/Gain Score Difference	119	8.40	2.51	20.75	5.10	6.87

Summary of result in Table 1 shows that students taught Chemistry using DTT had a higher mean achievement post-test score (23.69), having SD of 3.84,than those taught using LM (16.96), having SD of 3.89. These results show that the experimental group taught Chemistry with DTT had a higher mean achievement gain score of 15.53 (i.e. 23.69 – 8.34 = 15.35) than their counterparts in the control group taught with the LM which is 8.48 (i.e. 16.96 – 8.48 = 8.48), with a mean achievement gain score difference of 6.87 (i.e. 15.35 – 8.48 = 6.87). This implies that DTT enhanced the students' academic achievement in Chemistry than the LM. Nevertheless, the inferential statistics of ANCOVA will reveal if the difference in mean score is significant between the experimental group and control group.

Responses on mean achievement score of male and female students taught Chemistry using digital teaching tools (DTT).

For this research question, data obtained with the CAT for the treatment (DTT) group only was used to answer the research question. Summary of result of data analysis is presented in table 2.

Table 2: Summary of pre-test, post-test and standard deviation of mean achievement scores of male and female students taught Chemistry using DTT

Gender	N	Pre-test		Post-test		Gain Score
		Mean	SD	Mean	SD	
Male	20	9.55	2.56	22.90	4.10	13.35
Female	47	7.83	1.96	24.02	3.72	16.19
Total/Gain Score Difference	67	8.34	2.28	23.69	3.84	-2.84

Result on Table 2 showed that female students taught Chemistry using DTT had a higher mean achievement post-test score (24.02), having SD of 3.72, than their male counterparts (22.90), having SD of 4.103. This implies that DTT enhanced the female students' achievement score in Chemistry than their male counterparts. This result shows that the female students taught Chemistry with DTT had a higher mean achievement gain score of 16.19 (i.e. 24.02 – 7.83 = 16.19) than their male counterparts in the same experimental group taught Chemistry with DTT which is 13.35 (i.e. 22.90 – 9.55 = 13.35), with a mean achievement gain score difference of – 2.84 (i.e. 13.35 – 16.19 = – 2.84). This implies that DTT enhanced the female students' academic achievement in Chemistry than the male. Nevertheless, the inferential statistics of ANCOVA will reveal if the difference in mean score is significant between the two genders.

Response on interaction between gender and teaching approaches on students' mean achievement scores in Chemistry

Adjusted mean for the two levels of gender that were subjected to use of DTT and those subjected to the lecture method were used to access the interaction. Summary of result is presented in table 3.

Table 3: Summary of interaction between gender and teaching strategies on students mean performance score in Chemistry

Dependent Variable: Post-test score (Estimates)

				95% Confidence Interval	
Group	**Gender**	**Mean**	**Std. Error**	**Lower Bound**	**Upper Bound**
DTT	Male	19.074[a]	.605	17.876	20.272
	Female	20.839[a]	.386	20.073	21.604
LM	Male	9.440[a]	.388	8.671	10.209
	Female	8.146[a]	.246	7.658	8.634

a. Covariates appearing in the model are evaluated at the following values:
Pre-test = 8.40 & post-test = 20.75

Summary of result presented in Table 3 revealed clearly that the mean achievement scores of the experimental group taught Chemistry with DTT (19.074[a] for male and 20.839[a] for female) is higher than that of the control group taught Chemistry with LM (9.440[a] for male and 8.146[a] for female) at the two levels of gender (male and female respectively).This implies that DTT enhanced both the male and female students' achievement scores in Chemistry than that of their counterparts taught with LM. Nevertheless, the inferential statistics of ANCOVA will reveal if the interaction is significant.

Hypotheses

The three hypotheses 1, 2 & 3 were tested using ANCOVA. Summary of the analysis for the three null hypotheses is shown in Table 4.

Table 4: ANCOVA of students' mean achievement scores in Chemistry by teaching approaches (DTT& LM) and gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	1674.815[a]	4	418.704	34.201	.000	
Intercept	1762.995	1	1762.995	144.009	.000	
Pretest	320.854	1	320.854	26.209	.000	
DTT	1062.256	1	1062.256	86.769	.000	S
Gender	73.038	1	73.038	5.966	.016	S
DTT*Gender	6.390	1	6.390	.522	.472	NS
Error	1395.622	114	12.242			
Total	54297.000	119				
Corrected Total	3070.437	118				

For hypothesis 1, the ANCOVA table shows that the significant value of 0.000 is less than 0.05. The decision rule is to reject the null hypothesis when the sig. value is less than alpha value of 0.05. Since the sig. value is less than 0.05, the null hypothesis was rejected. The researchers concluded that there is a significant difference between the mean achievement scores of students taught Chemistry using DTT and that of those taught Chemistry using LM in favour of DTR group.

For hypothesis 2, the ANCOVA table shows that the significant value of 0.016 is less than 0.05. The decision rule is to reject the null hypothesis when the sig. value is less than alpha value of 0.05. Since the sig. value is less than 0.05, the null hypothesis was rejected. The study concludes that there is a significant difference between the mean achievement scores of male and female students taught Chemistry using DTT. This implies that DTT enhanced the academic achievement of female students more than the male students in Chemistry.

For hypothesis 3, the ANCOVA table shows that the significant value of 0.472 is greater than 0.05. The decision rule is not to reject the null hypothesis when the sig. value is greater than alpha value of 0.05. Based on the decision rule, the researcher did not reject the null hypothesis and

concludes that there is no significant interaction between gender and teaching approaches on students' mean achievement scores in Chemistry.

Discussion

Students taught Chemistry using digital teaching tools (DTT) had higher mean achievement scores than those taught using the lecture method (LM), and the difference in their mean achievement scores was statistically significant. DTT was superior to LM in enhancing the achievement of the learners. The finding of this study is in line with the observations of Ogunbodede & Oribhabor (2022), they found out that students that learned using Digital Resources had high-performance scores than students who learned through the lecture method of teaching in their undergraduate departmental courses. The study also agreed with observations of Kumi, et al. (2020) who found that students taught with Digital Technologies performed better in the online learning environment. The finding of this study is in line with the constructivists' theory which revealed that the students can construct their own knowledge by interacting with the objects in their environments. Constructivists admit that effective learning occurs when the learner is actively involved during teaching and learning encounter and therefore advocate for hands-on and minds-on pedagogy which DTT provides. The differences in achievement scores of students might have been as a result of the type of instructions presented to them. In DTT lesson, all learners had equal chances of learning and constructing their knowledge. The use of the DTT in the teaching made the facilitator and students to interact very well which made the students to freely express their opinions and it created opportunities for a deeper sense of responsibility for student during the learning process which made the students to learn concepts more than contents.

There was a significant difference between the mean achievement scores of male and female students taught Chemistry using DTT in favour of the female students. The findings of this study revealed that female students had slightly higher mean achievement score than their male counterparts and the difference in their mean achievement scores was statistically significant. This implies that DTT enhanced the academic achievement of female students' more than the male students in Chemistry. The findings from this study is not in line with the findings of Eden (2019) who found gender disparity in achievement in favour of male students even though this

study is in favour of female students. Meanwhile, the finding is not in line with the findings of Ahmed (2019) who found no gender disparity in achievement among students taught with digital tools.

There was no significant interaction between gender and teaching approaches on the achievement scores of the students because both male and female students in the treatment (DTT) group clearly had higher mean achievement scores than those in the control (LM) group. This implies that DTT is superior to LM at the two levels of gender (male and female).

Conclusion

From the results obtained in the study on the effects of Digital Teaching Tools (DTT) on academic achievement of students in Chemistry, it was found that DTT enhanced the achievement of Chemistry students. This implies that the students will do better in Chemistry when they are taught with use of DTT. Digital teaching tools were able to engage the students actively during the learning process thereby improving their academic achievement. DTT help students to overcome the impression that Chemistry is abstract and difficult. The attitude of absenting themselves from lesson will be drastically reduced because the interactive and interesting nature of DTT will entice them. There was no significant interaction between gender and teaching approaches on the mean achievement scores of the students in Chemistry because both male and female students in the treatment (DTT) group clearly had higher mean achievement scores than those in the control (LM) group. There was significant difference between genders on students' mean achievement scores in Chemistry when taught using DTT in favour of the female. This is of concern to the usage of approaches that will enhance achievement equally irrespective of gender.

Recommendations

This study recommends that Chemistry teachers should utilize DTT which is effective in enhancing students' achievement in Chemistry more than the lecture method. Also curriculum developers should develop a Chemistry curriculum that will take into considerations approaches like the DTT in teaching in secondary schools. More so further research should be conducted to determine the effect of DTT using various location. Seminars

and workshops should be organized by relevant professional bodies or departments to educate teachers on digital teaching tool usage and benefits.

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