BSU Journal of Science, Mathematics and Computer Education (BSU-JSMCE) Volume 5, Issue 2, July – December, 2025

EFFECT OF TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) MODEL ON SENIOR SECONDARY STUDENTS' INTEREST IN CHEMISTRY IN MAKURDI METROPOLIS

[1]Samuel Terfa Godo and [2]Peter Ogbu Agogo

[1&2]Department of Science and Mathematics Education, Rev. Fr. Moses Orshio Adasu University, Makurdi, Benue State, Nigeria.

Corresponding Author's Email: sgodo2453@gmail.com

Abstract

Effect of Technological Pedagogical Content Knowledge (TPACK)Model on Senior Secondary Students 'Interest in Chemistry in Makurdi Metropolis was investigated using pre-interest, post-interest control group quasi-experimental design. Two research questions and two hypotheses guided the study. The population of the study comprised all the 954 (687 Males and 267 females) senior secondary two Chemistry students in 16 co-educational public secondary schools in the 2024/2025 academic session. A sample of 112 Chemistry students (56 males and 56 females) SS2 was drawn using multi-stage sampling. The validated and trial tested Chemistry Interest Scale (CIS) used for data collection had a Cronbach's Alpha reliability co-efficient of 0.86. Data were analysed using mean and standard deviation to answer research questions while One-way Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 α-level. Findings revealed that there was significant difference in the mean interest rating of students taught Chemistry using TPACK Model and those taught using Discussion Teaching Method (DTM) [F (1, 109) =12.455; p =0.001 < 0.05]. Furthermore, the study showed that there was no significant difference in the mean interest rating scores of male and female students taught Chemistry using TPACK Model [F(1,55)=10.116;p=0.002 < 0.05]. The study recommends among others that Chemistry teachers should use TPACK Model for effective lesson delivery.

Key words: TPACK Model, Interest, Chemistry, Gender,

Introduction

In a broad sense, science could be seen as a field of study that enhances the general welling of humanity including health, agriculture, transportation and education of across nations. Samba (2019), and Nja and Ideba (2021) stated that the scientific knowledge, largely determines how people can manipulate their environment for quality living. It is thereby helping in inculcating into the young people the right scientific skills and attitudes needed to pursue science-based careers. This enables citizens to develop competencies for effective accomplishment in career for self-reliance and national

development through science education (Udu, 2018). Science education is the development of all round facet of human development for an individual to function meaningfully in the society. Adejoh and Ekele (2014) confirmed that science education is the aggregate of all the processes by which individuals develop interest, abilities, attitudes, knowledge and skills for the development of the society. Science education inculcates scientific literacy to individuals that are not originally part of a scientific community (Clement et al., 2017; Nja et al., 2022). This espouses the fact that appropriate delivery of science content such as Chemistry in secondary schools can enhance the effective impartation of scientific literacy and consciousness in citizens and prepare students for exploits in Chemistry and other sciences.

It is important to note that the production of essential human needs such as soap of all kinds, creams, drinks, petroleum and its by-products, clothing, drugs, household utensils and chemicals for the preservation of food items as well as textiles are all products of Chemistry. This aligns with the objectives of the National Policy on Education (FRN, 2014). Among the objectives are acquisition of scientific skills for national development and to provide manpower for pure and applied sciences. The place of Chemistry in the development of the scientific base of a country cannot be over emphasized (Ajayi et al., 2019). It is a perquisite science subject for science-based programmes like medicine, engineering, pharmacy and others. Chemistry is the study of composition, properties and reactions of matter and the use of such reactions to form new substances (Igboanugo, 2018). With the relevance of Chemistry in nation building and development there is need to improve on interest of students in the subject. This implies that there is a need of using innovative teaching strategies that will arouse students' interest that enable them to be part of knowledge gained and construction (Agu & Samuel, 2018; Ajayi & Angura, 2017). Such strategies include collaborative learning, games, simulation and Technological Pedagogical Content Knowledge (TPACK) (Oyelekan et al., 2017)

TPACK stands for Technological Pedagogical Content Knowledge-A framework that describes the combination of knowledge teachers need to integrate technology into their lesson delivery. This model was developed to explain the set of knowledge that teacher needs to teach their students a subject effectively using technological tools in lesson delivery. These tools are laptops, projectors, smartboards, Microsoft word and Microsoft PowerPoint. Others are Google classroom, WhatsApp, You-tube, Zoom, Google meet, WhatsApp videos Hyperchem and Chemsketch. All these combines to stimulate students' interest in the subject (Celik, 2023; Zhang and Tang, 2021). TPACK Model was introduced in educational research field as theoretical framework for understanding teacher knowledge required for effective technology integration. ((Mishra, 2019; Mishra & Koehler, 2006). It is a combination of content, theory and technology within the context of educational software design that would arouse interest of students in active learning.

Interest is useful in predicting the success and academic performance, which an individual is likely to obtain from engaging in certain activities now and in future. Low interest contributes to poor performance in Chemistry (Ogolum et al., 2021). There is therefore the need to capture and maintain the interest of students in learning Chemistry at the senior secondary school level. By arousing students' interest in learning Chemistry could enhance their commitment to studying and performing well in the

subject. According to Eze et al. (2024) students with high interest in a science subject like Chemistry, are likely to be more motivated to manage their own learning and develop the requisite skills to become effective learners of Chemistry. Godspower-Echie and Ihenko (2017) opined that Chemistry teachers should try to identify a method that can arouse students' interest.

The level of interest in learning Chemistry is influenced by numerous such teachers' attitude and competence, relevance to real life and career and teaching method can diminish students' interest. According to a study, interest is a component of personality that correlates with students' motivation, self- regulation and academic performance (Pranata et al., 2023). Encouraging interest in Chemistry during the school period is crucial because students who are interested in science are more likely to pursue careers in the field (Ogolom et al., 2021).This can lead to improved academic performance in Chemistry. The low performance of students in redox reactions is based on lack of interest or instructional method. Based on the gaps identified, the researcher intends to investigate using suitable innovative strategies that will hopefully arouse students' interest in Chemistry as well as gender factors.

Gender variance is as old as the world and has been used severally in academic discourse. It is the nature of being masculine or feminine; male or female. Gender disparity according to Danjuma (2015) globally militates against equitable participation of males and females in science education especially in Africa. Ali et al. (2014) submitted that females face a number of inequitable difficulties that limit their potentials in participation in the sciences. Byusa at al. (2021) asserted that male students are interested in learning Chemistry more than female, this is because male students want to deal with concepts in chemistry that related to outside of school experience. In addition, Thelwell and Nevill (2019) noted that female students show little interest in learning Chemistry. The implications are poor enrolment and poor academic performance in Chemistry. With such background, it is pertinent to look at previous empirical studies whether teaching with TPACK Model has effect on male and female students in Chemistry**.**

A study by Aldalalah et al. (2025) examined the effectiveness of interactive digital content based on the technological pedagogical content knowledge framework (TPACK) Model in developing the skills of educational aids production and enhancing cognitive achievement among early childhood students at Jadara University, Jordan. The results showed the effectiveness of interactive digital content based on the TPACK Model in developing skills for producing educational aids and cognitive achievement. Pramanik et al. (2023) examined TPACK of Science Teachers at the Higher Secondary stage in the COVID 19 Era. The study found that science teachers in Cuttack, India, had good knowledge of TPACK and there was no significant difference in the TPACK means scores of novice and experienced teachers. Similarly, Deng et al. (2023) conducted a study titled: Examining pre-service Chemistry teachers TPACK using data –logging, Guangdong, China. This study revealed a significant correlation between pre-service Chemistry teachers' data-logging TPACK and their capacity for design thinking. In light of these findings, this study not only contributes to our understanding of TPACK development but also has practical implications for

nurturing pre service Chemistry teachers' proficiency in TPACK when using data logging which necessary curriculum delivery.

Nnadi and Ali (2023) investigated impact of self-regulated learning strategy with you tube videos on secondary school students' interest in Physics. The result of the study showed that the students who learned Physics using YouTube videos with self-regulated learning strategy had more interest than those students who learned Physics using expository lecture method. It also showed that there was no significant difference between the mean situational interest scores of male and female students taught Physics using SRLS. Amadi (2021) in a study carried out on analysis of students' interest and mathematical ability as correlates to Chemistry achievement in secondary schools in Rivers State, the study adopted a correlational design. Results of this study revealed a high positive relationship of 0.814 between students' interest and Chemistry students' academic performance. In a study by Eze et al. (2020) titled: effect of integrating of multimedia in teaching and learning of Chemistry on secondary school students' achievement and interest. Results of analysis showed that students taught Chemistry by integrating multimedia in the teaching process recorded higher achievement and interest than those taught without the integration of multimedia. Findings further revealed that there was no significant difference in mean interest rating of male and female students. In another study, Gongden et al. (2020) examined the effects of animation instructional strategy (ANIS) on senior secondary one-chemistry students' interest and achievement in chemical bonding in Shendam - Nigeria. The study revealed a significant difference between the mean interest scores of experimental and control groups in favour of the experimental group.

Studies reviewed indicated that TPACK Model-based teaching enhances students' engagement and arouse interest in science subjects. However, while its application in subjects like Physics and Biology has been explored, limited studies has examined its effectiveness in Chemistry, particularly in redox reactions. The theoretical gap lies in the limited studies on the integration of the TPACK Model within Chemistry education, particularly for redox reactions. A contextual gap is evident, as most studies on innovative Chemistry teaching strategies have been conducted within Nigeria, some on Chemistry teachers' competence in curriculum delivery using TPACK and a few outside Nigeria with little focus on Makurdi Metropolis. Finally, a topic-specific gap persists, as redox reactions remain underrepresented in studies on technology-based teaching interventions. Given these gaps, the effect of TPACK Model on senior secondary students' interest in Chemistry in Makurdi Metropolis study was necessitated.

Statement of Problem

Interest in science is critical for functional education. However, low students' interest has been observed in Chemistry. Oloyede and Adebayo (2021) confirmed that students' interest in Chemistry is still low because of poor teaching methods employed by Chemistry teachers. This low interest in Chemistry discourages students from pursuing careers in medicine, engineering, pharmacy and other STEM disciplines, widening the work force gap.

In Nigeria, Chemistry at the senior secondary level serve as the foundation of science learning at tertiary education. However, the aim seems to be hindered by some factors among which teaching strategy

is key (Agboola & Loto, 2020). It is against this background that this study seeks to investigate effect of TPACK Model on senior secondary students' interest in Makurdi Metropolis with the following objectives;

1. Find out the effect of TPACK Model on students' interest rating scores taught Chemistry using TPACK model and those taught using Discussion Teaching Method (DTM).
2. Determine the effect on male and female students' interest rating scores taught Chemistry using TPACK model.

Research questions

The following research questions guided the study;

1. What is the mean difference in students' interest rating scores taught Chemistry using TPACK model and those taught using Discussion Teaching Method (DTM)?
2. What is the difference in the mean interest rating scores of male and female students taught Chemistry using TPACK model?

Hypotheses

The following hypotheses were formulated and tested at 0.05 α-level

1. There is no significant difference in the mean interest rating scores of students taught Chemistry using TPACK Model and those taught using Discussion Teaching Method (DTM).
2. There is no significant difference in the mean interest rating scores of male and female students taught Chemistry using TPACK Model.

Method

This study adopted quasi-experimental design of non-randomized pre-interest and post-interest, control group to measure effect of technological pedagogical content knowledge (TPACK) Model on secondary students' interest in Chemistry in Makurdi Metropolis. The choice of this design was because the study aims to establish cause and effect relationship between variables (White & Sabarwal, 2014; Agogo & Achor, 2019). The experimental group was taught using TPACK Model while the control group was taught using discussion teaching method for five weeks Data collection involved pre-interest and post-interest to measure students' interest. The population for this study consists of all the 954 (Male-687 and Female-267) senior secondary two (SS2) Chemistry students in all the 16 co-educational public schools in Makurdi Metropolis of Benue State (Benue State Teaching Service Board,2024/2025). The sample for the study consists of 112 Senior Secondary Two (SS2) Chemistry students drawn using multistage sampling procedure from population in 16 co-educational public schools. Chemistry Interest Scale (CIS) was validated by three experts, a sample of 28 SS2 Chemistry students was trial tested and scores collected were computed using Cronbach's alpha which yielded a reliability coefficient of 0.86. CIS was made up of two sections; Section A and Section B, Section A contained bio-data and Section B contained a 30-item structured with four-point Likert rating scale with four response options. The options were Strongly Agree (SA)-4, Agree (A)-3, Disagree (D)-2 and Strongly Disagree (SD)-1 was used for data collection. The researcher developed ten lesson plans on redox reactions concept in Chemistry. The researcher trained two chemistry teachers as research assistants for this study. Five (5) lesson were delivered in accordance with the principles of TPACK Model in experimental group. In the process of experimental procedure, extraneous variables such as baseline group differences and

interaction effects were statistically controlled using ANCOVA, which adjusts pre-interest scores. Meanwhile, control group were taught the same concept with five (5) lesson plans prepared in line with Discussion Teaching Method (DTM). The pre-interest was administered to both experimental and control groups before treatment. Research questions were answered using mean and standard deviation while hypotheses were tested at 0.05 level of significance using ANCOVA. The choice of ANCOVA for testing is justified as it helps control for initial differences in students' interest before the intervention (use of the TPACK Model).

Result

Research Question One: What is the mean difference in the interest rating scores of students taught Chemistry using TPACK Model and those taught using Discussion Teaching Method (DTM)?

Table 1: Mean and Standard Deviation of Students' Interest Rating based on Teaching Method

Method	**Sample (n)**	**Pre-Interest**		**Post-Interest**		**Gain**
		Mean	**SD**	**Mean**	**SD**	
TPACK Model	58	2.95	0.39	3.49	0.41	0.54
Discussion Teaching Method	54	2.91	0.48	3.22	0.12	0.31
Mean Difference	**112**	**0.04**		**0.27**		**0.23**

The results in Table 1 revealed that students Chemistry using TPACK Model had interest rating mean scores of 2.95 with standard deviation of 0.39 in the Pre-Interest and interest rating mean scores of 3.49 with standard deviation of 0.41 in the post-interest. Students taught Chemistry using Discussion Teaching Method had interest rating mean scores of 2.91 with standard deviation of 0.48 in the Pre-Interest and interest rating mean scores of 3.22 with standard deviation of 0.12 in the post-interest. Table 1 further showed that students taught using TPACK Model had mean gain scores of 0.54 while those taught using Discussion Teaching Method had a mean gain score of 0.31. Thus, there was a mean gain difference of 0.23 in favour of students taught Chemistry using TPACK Model. This showed that students taught using TPACK Model increases interest more as compared to those taught using Discussion Teaching Method.

Research question Two: What is the difference in the mean interest rating scores of male and female students Chemistry with TPACK Model?

Table 2: Mean and Standard Deviation of Interest rating of Male and Female Students Taught Chemistry using TPACK Model.

Gender	**Sample (n)**	**Pre-interest**		**Post-interest**		**Gain**
		Mean	**SD**	**Mean**	**SD**	
Male	25	2.88	0.37	3.64	0.44	0.76
Female	33	3.00	0.39	3.38	0.34	0.38
Mean Difference		**0.12**		**0.26**		**0.38**

The results in Table 2 showed that male students taught Chemistry using TPACK Model had interest rating mean scores of 2.88 with standard deviation of 0.37 in the Pre-Interest and interest rating mean scores of 3.64 with standard deviation of 0.44 in the post-interest. Female students who were taught Chemistry using the same TPACK Model had interest rating mean scores of 3.00 with standard deviation of 0.39 in the Pre-Interest and interest rating mean scores of 3.38 with standard deviation of 3.38 in the Post-test. Table 2 also revealed that male students taught Chemistry using TPACK Model had mean gain scores of 0.76 while female students taught using the same TPACK Model had a mean gain score of 0.38 with a trivial mean gain difference of 0.38 in favour of the male students taught Chemistry using TPACK Model. This explained that male students taught using TPACK Model increased interest as compared to their female counterpart students taught Chemistry using the TPACK Model.

Hypothesis One: There is no significant difference in the mean interest rating scores of students taught Chemistry using TPACK model and those taught using Discussion Teaching Method (DTM).

Table 3: ANCOVA Summary of Students' Interest Rating Scores Based on Teaching Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.502[a]	2	1.751	11.136	.000	.170
Intercept	15.752	1	15.752	100.195	.000	.479
Pre-Interest	1.391	1	1.391	8.849	.004	.075
Teaching Method	**1.958**	**1**	**1.958**	**12.455**	**.001**	**.103**
Error	17.136	109	.157			
Total	1284.267	112				
Corrected Total	20.638	111				

The ANCOVA statistic summary in Table 3 showed that F (1,109) = 12.455; ρ = 0.001 < 0.05. This suggests that the probability level is less than the specified alpha of 0.05. Thus, the null hypothesis was rejected. It means that there was a significant difference in the interest rating mean scores of students taught using TPACK Model and those taught using discussion teaching method in Chemistry. This implies that TPACK Model significantly developed students' interest more than discussion teaching method. The partial eta squared value of 0.103 is considered a large effect size, indicating that the TPACK Model has a substantial impact on students' interest. This means that approximately 10.3% of the variance in students' interest can be attributed to the difference between the two teaching methods and there is a strong association between the TPACK Model and students' interest.

Hypothesis Two: There is no significant difference in the mean interest rating scores of male and female students taught Chemistry using TPACK model.

Table 4: ANCOVA Summary of Students' Interest Rating Based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.147[a]	2	1.074	8.219	.001	.230
Intercept	5.574	1	5.574	42.666	.000	.437
Pre-Interest TPACK	1.142	1	1.142	8.740	.005	.137
Gender	**1.321**	**1**	**1.321**	**10.116**	**.002**	**.155**
Error	7.185	55	.131			
Total	716.337	58				
Corrected Total	9.332	57				

The ANCOVA statistic summary in Table 4 states that $F(1, 55) = 10.116$; $\rho = 0.002 < 0.05$. This specifies that the probability level is less than the stated alpha of 0.05. Thus, the null hypothesis was rejected. This indicates that there was a significant difference in the interest rating mean scores of male and female students taught Chemistry using TPACK Model. It means that TPACK Model is effective and has significant gender-based disparities in learning outcomes for both males and females. The partial eta squared value of 0.155 is considered as a large effect size, indicating that male and female students perform differently in interest when taught using TPACK Model. This means that approximately 15.5% of the variance of students' interest can be attributed to a statistically significant difference between male and female students.

Discussion of Findings

The study investigated effect of technological pedagogical content knowledge model on senior secondary students' interest in Chemistry in Makurdi Metropolis. Findings of this study revealed that students taught Chemistry using TPACK Model gained more interest than those taught using DTM. ANCOVA test showed that there was a significant difference in the interest rating mean scores of students taught Chemistry using TPACK Model and those taught using DTM. The significant difference recorded in TPACK Model over DTM is because TPACK Model integrates technological tools such as hardware (laptop, projector), software (Power Point presentations) and digital platforms (You Tube videos). These tools make redox reactions concept visual, interactive and relatable, thereby increasing interest of students in learning. This study validates Nnadi and Ali (2023), Amadi (2021), Eze et al. (2020) and Gongden et al. (2020) whose studies showed that students who learned Physics, Mathematics and Chemistry using technological tools (YouTube videos, multimedia and animation instructional strategy) had more interest than those students who learned these sciences using conventional methods.

Findings further revealed that male students taught Chemistry using TPACK Model gained more interest. This explains that male students taught Chemistry using TPACK Model increased interest as compared to their female counterpart taught using TPACK Model. ANCOVA test showed that there was a significant difference in the mean interest rating scores of male and female students taught Chemistry using TPACK Model. It means that TPACK Model is effective and has significant gender-based disparities in learning outcomes for both male and female students. It suggests that both male and female students responded differently to the instructional method. This is because of persistent stereotypes that affect perception and interest,

particularly female students experience low interest in Chemistry even when using innovative teaching strategy such as TPACK Model. In addition, male students exhibit greater familiarity and confidence in technological tools and showing more interest in abstract and problem-solving tasks. These findings agree with Nnadi and Ali (2023) and Godpower-Echie and Ihenko (2017) who found that gender has positive influence on interest. It confirmed that if teachers integrate technological tools showing real-world applications, it enhances motivation and increase interest in learning Chemistry.

Conclusion

Going by the findings of the study, it be concluded that Technological Pedagogical Content Knowledge (TPACK) Model provides a way of stimulating male students' interest in Chemistry more than females. In addition, TPACK has foster a way of overcoming difficulty in understanding difficult concepts in Chemistry.

Recommendations

The following recommendations were made:

1. Chemistry teachers should use TPACK Model in lesson delivery to arouse male and female students' interest in Chemistry.
2. Curriculum integration of TPACK-aligned resources; technological tools used must align with Chemistry curriculum goals for meaningful learning.

References

Adejoh, M. J., & Ekele, G. E. (2014). *Contemporary issues in science, technology and agricultural education.* Micro-teacher and Associates.

Agogo. P. O., & Achor, E. E. (2019). *Research methods and statistics for beginners.* Optimism Press.

Agboola, A., & Loto, A. B. (2020). Influence of virtual laboratory on students' interest and academic achievement in chemistry. *Journal of Science Education and Technology, 29*(5), 741-752.

Agu, P. A., & Samuel, I. R. (2018). Effect of simulation instructional package on basic science and technology students' achievement and retention in Federal Capital Territory Abuja, Nigeria. *International Journal of Innovative Education Research, 6*(3), 1-7.

Ajayi, V. O., & Angura, T. (2017). Improving senior secondary retention in electrolysis using collaborative concept mapping instructional strategy (CCMIS). *Greener Journal of Educational Research, 7*(6), 87-92.

Ajayi, V. O., Achor, E. E., & Otor, E. E. (2019). Improving teaching quality in science education using Kolb's learning model and 5E learning model. *Journal of Research in Curriculum and Teaching 11*(1), 1-13.

Aldalalah, O. M., A., Wardat, A., Al-Omari, A. A. H., & Khodair, R. M. (2025). The effectiveness of interactive digital content based on TPACK Model in developing the skills of educational aids production and improving cognitive achievement among early childhood university students. *Contemporary Educational Technology, 17*(2), ep572. https://doi.org/10.30935/cedtech/16046

Amadi, J. N. (2021). Analysis of students' interest and mathematical ability as correlates chemistry achievement in secondary schools in Rivers State. *Rivers State University Journal of Education, 24*(2), 113-119.

Baanu, T. F., Oyelekan, O. S. & Adekunle, S. O. (2018). Self-efficacy and chemistry students' academic achievement in senior secondary schools in North Central Nigeria. *Malaysian Online Journal of Educational Sciences, 4*(1), 43-52.

Benue State Teaching Board (2024). *Population of students in Makurdi Local Government Area of Benue State.* Department of Research and Statistics.

Byusa, E., Kampire, E. & Mwesigye, A. R. (2020). Analysis of teaching techniques and scheme of work in teaching chemistry in Rwandan secondary schools. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(6), 1-9.

Celik, I. (2023). Towards intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior, 138,* 107468. https://doi.org/10.1016/j.chb.2022.107468

Clement, I., Bello, M. & Sunusi, S. A. (2017). Science education and Nigeria national development effort: The missing link. *International Journal of Education and Evaluation, 3*(5), 46-56.

Danjuma, G. S. (2015). *Effect of collaborative and competitive learning strategies on upper basic two students' interest and achievement in basic science.* PhD Science Education thesis, University of Nigeria.

Deng, F., Lan, W., Sun, D., & Zhang, Z (2023). Examining pre-service chemistry teachers TPACK of using data-logging in the chemistry classroom. *Sustainability, 15,* 15441, https://doi.org/10.3390/su152115441

Eze, C. U., Okeke, H. K. & Ukeh, B. O. (2020). Effect of integrating multimedia in teaching and learning of chemistry on secondary school students' achievement and interest. *BSU Journal of Science and Mathematics and Computer Education, 1*(1), 23-31.

Eze, C. U., Egbo, J. J. & Okechineke, B. C. (2024). Effect of four-mode applications on students' interest in secondary school chemistry. *Enugu State University of Technology Journal of Education, 7*(1), 99-111.

Federal Republic of Nigeria-FRN (2014). *National Policy on Education.* Nigeria Educational Research and Development Council Printing Press.

Godpower-Echie, G., & Ihenko, S. (2017). Influence of gender on interest and academic achievement of students in integrated science in Obio Akpor Local Government Area of Rivers State. *European Scientific Journal, 13*(10), 1857 – 7881.

Gongden, E. J., Yame, P.T. & Gongden, E. E. (2020). The effects of computer animation instructional strategy on students' interest and achievement in chemical bonding in Shendam, Plateau State, Nigeria. *American Journal of Humanities and Social Sciences Research 4*(7), 304-311.

Igboanugo, B. I. (2018). *Interactive effects of science-technology-society instructional approach, teacher experience, gender, and school location on students' achievement and interest in chemistry.* Unpublished PhD thesis, University of Nigeria.

Kyado, J. J., Achor., E. E & Adah. E. H. (2021). Identification of difficult concepts in Chemistry by some secondary school students and teachers in Nigeria. *ICSHE Journal, 5*(1), 99-111.

Mishra, P. (2019). Considering Contextual Knowledge: The TPACK diagram gets an upgrade. *Journal of Digital Learning in Teacher Education, 35*(2), 76-78.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for Teachers Knowledge. *Teachers College Records, 108*(6), 1017-1054.

Nja, C. O., & Ideba, M. A. (2021). Home materials and academic achievements of chemistry students. *Inter-Disciplinary Journal of Science Education, 3*(1), 57-67.

Nja, C., Ukwetang, J., Orim, R., Neji, H., Edu, G., Ukah, J., & Olofu, M. (2022). Cultural resources, academic self-concept and achievement of chemistry students in senior secondary schools of Calabar Municipality, Cross River State, Nigeria. *Frontiers in Education, 7:* 896833. https://doi.org/10.3389/feduc.2022.896833

Nnadi, F.O., & Ali, O.O (2023). Impact of self-regulated learning strategy with You Tube on secondary school students' interest in practical physics. *ESUT Journal of Education, 6*(1), 11-21.

Ogolom, E.V., Samuel, N. N. & Okonkwo, I. G. A. (2021). Enhancing students' interest in chemistry through problem – solving skills. *Southern Eastern Journal of Research and Sustainable Development, 4*(2), 116-128.

Oyelekan. O. S., Igbokwe, E. F., & Olorundare, A. S. (2017). Science teachers' utilization of innovative strategies for teaching senior school science in Ilorin, Nigeria. *Malaysian Online Journal of Educational Sciences, 5*(2), 49-65.

Oloyede, E. O., & Adedayo, J. O. (2021). Effect of flipped classroom on senior secondary school students' achievement and interest in chemistry. *International Journal of Educational Research Review, 6*(1), 1-9.

Pramanik, A., Deb, J. P., & Dash, N. (2023). A study of TPACK of science teachers at the higher secondary stage. *Journal for Humanity Science and English Language, 11*(56).

Pranata, O. D., Hafifah,A., & Ramadani,O (2024). Students' perception of science and technology in science learning. A gender comparative study. *Jurnal Pijar Mipa, 19*(1), 44-54.http://doi.org/10. 29303/jpm.vl9i/.6153

Samba, R. M. O. (2019, August 26). *Science and technological education for sustainable development: Redefining STEM curriculum and teacher quality.* Being a lead paper presented at the 2nd Annual Interactional Conference of Federal College of Education, Pankshin, Plateau State, Nigeria.

Thelwell, M. & Nevill, L. (2019). No evidence of criterion bias as determinant of STEM gender disparities in US Biochemistry, Genetics and Molecular Biology. *Scientometrics, 121*(3), 1793-1801.

Udu, D. A. (2018). Innovative Practices in Science education. A panacea for improving secondary school students' academic performance in science subjects in Nigeria. *Global Journal of Educational Research, 17, 23*-30.

West African Examinations Council (2020-2023). *Chief Examiners Report*.

https://waeconline.org.ng/e-learning/Chemistry/chem

White, H., & Sarbarwal, S. (2014). Quasi-experimental design and methods: Methodological briefs: *Impact Evaluation 8*(8) Florence: UNICEF Office of Research.

Zhang, W. & Tang, J. H. (2021). Teachers' TPACK development: A review of literature. *Open Journal of Social Sciences, 9,* 367-380.