IMPACT OF DIGITAL TECHNOLOGY ON TEACHING AND LEARNING OF CHEMISTRY IN SOME SELECTED SECONDARY SCHOOLS OF MANGU LGA O F PLATEAU STATE

BY

Shenae, Sheman
Department of Chemistry, College of Education, Gindiri
shemanshenae84@gmail.com
&
Kutyom Sati Simon
Department of Chemistry, College of Education, Gindiri
satikutyomsimon@gmail.com

Abstract
This study examines the impact of digital technology on the teaching and learning of chemistry in selected secondary schools of Mangu LGA, Plateau State. Using a descriptive survey design, data was collected from 18 chemistry teachers via a validated questionnaire. Findings indicate that digital technology significantly enhances student engagement, understanding, and perfor mance in chemistry, with benefits including interactive learning, improved practical skills thro ugh virtual experiments, and increased motivation. However, challenges such as inadequate po wer supply, high costs of digital devices, and limited internet access hinder effective integration Despite recognizing its advantages, actual implementation remains low due to infrastructural and institutional barriers. The study recommends government intervention in improving power supply, teacher training in digital literacy, and curriculum reforms to incorporate technology-b ased learning. These measures could bridge the gap between digital technology's potential and its practical application in chemistry education, fostering better learning outcomes in Mangu L GA and similar regions. **Key Words:** Impact, Digital Technology, Tea ching, Learning, Chemistry, Secondary Schools

Introduction

In recent decades, digital technology has fundamentally transformed various aspects of human l ife, including education. The widespread adoption of electronic devices such as cell phones, vid eo cameras, personal digital assistants, and laptops with wireless internet connectivity has revol utionized the way people live, work, and learn (Ryan, 2013). The integration of digital technolo gy into educational settings has created significant opportunities for enhancing teaching and lea rning methodologies, particularly in science subjects like chemistry. Digital technology is now widely accepted as an essential tool for facilitating rapid changes in educational approaches and promoting educational goals (Hoostrurj, 2015).

The penetrating influence of digital technology extends beyond general education to specific fi elds like chemistry education, where it serves as a transformative agent in educational delivery and methodology. According to Olorundare (2019), the utilization of digital technology in curri culum development, implementation, and evaluation has brought tremendous changes to the ed ucation sector. The integration of digital tools in chemistry education has become a central focu s of many countries' education policies, leading to widespread adoption across various school s ystems in both developed and developing nations.

As an agent of change for effective teaching and learning in chemistry, digital technology offers multiple benefits, including serving as a source of knowledge, a medium for transmitting conten t from teachers to students, and a means of fostering engagement and networking opportunities

(Olorundare, 2019). According to Akçayır (2017), schools and learning institutions now provid e computer and information technology as learning materials to enhance knowledge acquisition and experiential learning. The integration of multimedia activities and digital tools in chemistry education can improve students' interest levels and creative thinking abilities, leading to more e ffective learning outcomes and enhanced academic performance.

CHALLENGES OF INTEGRATING DIGITAL TOOLS IN TEACHING

Despite the potential benefits of digital technology in chemistry education, its effective integrati on and impact on teaching and learning processes in secondary schools of Mangu Local Govern ment Area of Plateau State remains underexplored. Traditional teaching methods still dominate many chemistry classrooms in this region, limiting students' engagement and understanding of complex chemical concepts and processes. The gap between the rapid advancement of digital te chnology and its actual implementation in chemistry education raises concerns about whether st udents are receiving an education that prepares them for the technological demands of the conte mporary world. Additionally, challenges such as inadequate infrastructure, limited access to dig ital resources, insufficient teacher training, and inconsistent power supply may impede the succ essful integration of digital technology in chemistry education in this area. Therefore, this study aims to investigate the extent to which digital technology impacts the teaching and learning of c hemistry in selected secondary schools of Mangu LGA, identifying both the challenges and ben efits associated with its implementation, and examining how digital simulations and virtual exp eriments affect students' practical skills and experimental understanding in chemistry education
The main aim of this study is to investigate the impact of digital technology on teaching and lear ning of chemistry in some selected secondary schools in Mangu LGA of Plateau State.
The specific objectives of this study are to:

1. Determine the extent to which the integration of digital technology in chemistry classro oms enhances student engagement and understanding.
2. Identify the perceived challenges and benefits of incorporating digital technology in che mistry instruction among secondary school teachers.
3. Examine how the use of digital simulations and virtual experiments impacts students' pr actical skills and experimental understanding in chemistry education.

This study will provide valuable insights for chemistry teachers regarding the effectiven ess of integrating digital technology into their teaching methodologies. By highlighting both the challenges and benefits associated with digital technology implementation, teachers can make i nformed decisions about incorporating these tools to enhance student engagement and understa nding of chemistry concepts. Additionally, the findings will help teachers identify appropriate d igital resources and strategies for improving classroom instruction and student outcomes.
For educational administrators and policymakers, this research will offer evidence-based infor mation to guide decisions regarding investment in digital infrastructure and resources for chemi stry education. Understanding the impact of digital technology on teaching and learning outcom es will assist in developing policies that promote effective integration of technology in chemistr y education, thereby improving the quality of science education in secondary schools within M angu LGA and beyond.
Moreover, this study will contribute to the existing body of literature on digital technology in ch emistry education, particularly in the context of developing regions. By examining the specific challenges and benefits of technology integration in Mangu LGA, the research will provide loca lized insights that can inform broader discussions about digital technology in science education. This knowledge will be valuable for researchers, curriculum developers, and educational techn ologists working to enhance chemistry education through digital innovations.

CONCEPT OF CHEMISTRY

Chemistry is a fundamental branch of science concerned with the study of matter, including the identification, investigation, and manipulation of substances and their properties (Erinosho, 2017). As a core scientific discipline, chemistry focuses on exploring the composition of matter, investigating its properties and reactions, and utilizing these reactions to form new substances. The knowledge of chemistry is essential for students pursuing studies in various scientific fields, including biology, geology, and physics, making it central to the overall study of science (Nwanze et al., 2018). Despite its fundamental importance, chemistry is often perceived as a challenging subject across educational levels, partly due to its abstract nature and the cognitive demands it places on students (O'dwyer, 2012). This perception is reflected in students' academic performance, as evidenced by the reports from the West African Secondary School Certificate Examination (WASSCE), which show fluctuating performance levels in chemistry, with many years recording less than 50% credit passes (Konyefa & Nwanze, 2020). Research studies have consistently identified instructional approaches as a significant factor contributing to students' poor achievement in chemistry, emphasizing the need for innovative teaching strategies that can effectively link chemistry learning to real-world applications and enhance students' engagement and understanding (Enekwechi et al., 2019).

DIGITAL TECHNOLOGY IN EDUCATION

Digital technology in education encompasses the integration of technical devices and resources used to transmit, store, and manage information in the educational process (Singh, 2013). According to Murray (2011), digital technology accentuates the role of integrated communications, while Foldoc (2008) defines it as the integration of telecommunications, computers, and necessary enterprise software. The utilization of digital technology in education can be categorized into two general classifications: technologies specifically designed for educational purposes and general technologies adapted for educational use (Okoro & Ekpo, 2016). The incorporation of digital technology in education represents a significant shift from traditional teaching methods, offering innovative approaches to enhance the teaching and learning process. As noted by Davis and Tearle (as cited in Yusuf, 2015), digital technology has the potential to accelerate, enhance, and extend educational reforms by engaging and motivating learners and helping schools improve their financial and operational practices. Ashley (2016) further emphasizes that digital technology helps educators prepare students for real-world settings, arguing that as societies become increasingly technology-dependent, students must develop technological literacy to become effective citizens. The integration of digital technology in education provides a new and advanced learning environment that enables students to develop critical thinking, research, and evaluation skills necessary for success in the contemporary world (Salehi & Salehi, 2012).

DIGITAL TECHNOLOGY IN SCHOOLS

Digital technology in schools offers numerous opportunities for transforming educational practices by providing enhanced educational content and more effective teaching and learning methods. According to Haddad and Jurich (2018), the integration of digital technology in schools enhances the instructional process through the provision of interactive educational materials that increase learner motivation and facilitate the acquisition of essential skills. The use of multimedia tools such as television recordings, videos, and computer applications creates a more challenging and engaging learning environment for students of all ages. Furthermore, digital technology expands the flexibility of educational delivery, allowing students to access information anytime and anywhere, thereby making the learning process more student-centered and improving the overall quality of education (Moore & Kearsley, 2019). One significant advantage of introducing digital technology in schools is that it provides access to digital resources for students who may not have them at home, thereby reducing digital inequality. Digital technology can be used as a learning tool to enhance students' learning experiences and retention, motivating them and brin

ging dynamism to the classroom while reducing learning time (Aslan & Dogdu, 2020). Moreover, digital technology can enhance the quality of education by increasing student motivation and teacher effectiveness, which are foundational for developing higher-order thinking skills (Aslan & Dogdu, 2016).

METHOD AND PROCEDURES

This study employed a descriptive survey research design to investigate the impact of digital technology on teaching and learning of chemistry in selected secondary schools in Mangu LGA. The population comprised all chemistry teachers in Mangu Local Government Area, with a sample of 18 chemistry teachers selected from four secondary schools in Gindiri community using simple random sampling technique. Data was collected using a researcher-developed questionnaire titled "Digital Technology and Teaching Chemistry Questionnaire (DTTCQ)," which consisted of two sections: bio-data information and questionnaire items organized on a five-point Likert scale (Strongly Agree=5, Agree=4, Undecided=3, Disagree=2, Strongly Disagree=1). The instrument was validated by two research experts from the measurement and evaluation unit of College of Education Gindiri, and its reliability was established through a test-retest method, yielding a correlation coefficient of 0.70. The questionnaires were personally administered by the researcher, and completed questionnaires were retrieved immediately. Data analysis was conducted using descriptive statistics (mean and standard deviation) to answer the research questions, with a criterion mean of 3.5 for acceptance, while t-test was used to test the hypotheses at 0.05 level of significance.

RESULTS AND DISCUSSIONS

RESULTS

Research Question 1: To what extent does the integration of digital technology in chemistry classrooms enhance student engagement and understanding?

Table 1: Mean and standard deviation of extent to which the integration of digital technology in chemistry classrooms enhances students' engagement and understanding

Items	Sample	Mean	SD	Decision
The online learning/teaching is effective for learning all aspects of Chemistry	18	3.56	0.20	High Extent
Digitalization develops student's analytical skills in Chemistry	18	3.60	0.23	High Extent
Digitalization raises students' motivation as well as helps them not to guess too much	18	3.52	0.19	High Extent
Learning with digitized material supports the achievement of the learning goals	18	3.79	0.21	High Extent
It allows students to use various kinds of technology to conduct research, communicate and create knowledge	18	3.50	0.12	High Extent

Table 1 reveals that the average mean scores of respondents range between 3.50 (SD=0.12) and 3.79 (SD=0.21). All items had mean scores above the criterion mean of 3.5, with item 4 (Learning with digitized material supports the achievement of the learning goals) ranking highest. This indicates that respondents agreed that, to a high extent, digitalization impacts the teaching and learning of chemistry in secondary schools in Mangu LGA.

Research Question 2: What are the challenges and benefits of digital technology in teaching and learning chemistry in secondary schools in Mangu LGA?

Table 2: Mean and standard deviation of challenges of digital technology in teaching and learning chemistry in secondary schools

Items	Sample	Mean	SD	Decision
Digital devices are expensive to maintain	18	3.70	0.17	Agreed

Digital devices are expensive to acquire	18	4.00	0.11	Agreed
The cost of internet subscription is not an impediment	18	4.50	0.10	Agreed
Software packages for drawing and labeling poses a challenge	18	3.80	0.12	Agreed
Power supply is not inadequate	18	4.98	0.14	Agreed
Laboratory digital devices are readily available and affordable	18	2.30	0.40	Disagree

Table 2 shows that respondents agreed with all items as challenges to digitalization in teaching and learning chemistry, with mean scores exceeding the criterion mean of 3.5, except for item 6 (Laboratory digital devices are readily available and affordable) which had a mean score of 2.30 Inadequate power supply emerged as the most significant challenge, with the highest mean score of 4.98.

Table 3: Mean and standard deviation of benefits of digital technology in teaching and learning chemistry in secondary schools

Items	Sample	Mean	SD	Decision
Digital learning increases students' performance in Chemistry	18	4.05	0.10	Agreed
Digitalization of the teaching and learning of Chemistry makes students self-motivated and more accountable	18	3.59	0.13	Agreed
Digital learning tools involve educators and parents to a deeper extent	18	3.80	0.12	Agreed
Digitalization of the teaching and learning of Chemistry is far more interactive and memorable than voluminous textbooks or one-sided lessons	18	3.68	0.22	Agreed
Digital learning tools and technology is rapidly increasing information sharing in the teaching and learning of Chemistry	18	3.50	0.11	Agreed
Digital learning tools and technology enable educators to rapidly share information with other educators in real-time	18	3.50	0.20	Agreed

Table 3 reveals that all items had mean scores above the criterion mean of 3.5, indicating that respondents agreed with all the stated benefits of digitalizing teaching and learning chemistry. "Digital learning increases students' performance in Chemistry" received the highest mean score (4.05), highlighting its perceived importance.

Research Question 3: How does the use of digital simulation and virtual experiments impact students' practical skills and experimental understanding in chemistry education?

Table 4: Mean and standard deviation of how digital simulation and virtual experiments impact students' practical skills and experimental understanding in chemistry education

Item	Sample	Mean	SD	Decision
Students gain a deeper understanding of scientific principles and processes	18	3.30	0.25	High Extent
Virtual experiments allow students to conduct experiments repeatedly	18	3.50	0.24	High Extent
Students can learn at their pace	18	3.55	0.30	High Extent
Students can explore complex experiments without the fear of accidents or damage	18	3.20	0.20	High Extent
Virtual experiments offer a cost-effective alternati	18	3.00	0.12	High Exte

ve						nt

Table 4 shows that all items had mean scores at or above 3.0, though some fell below the criterion mean of 3.5. This indicates that digital simulations and virtual experiments impact students' practical skills and experimental understanding in chemistry education to a moderate to high extent, with the ability to "learn at their own pace" (3.55) being the most highly rated benefit.

Hypothesis Testing

Hypothesis One: There is no significant integration of digital technology in chemistry classrooms to enhance student engagement and understanding.

Table 5: Summary of t-test on significant integration of digital technology in chemistry classrooms to enhance student's engagement and understanding

N	Mean	SD	df	t-cal	t-crit	Decision
18	2.50	0.23	56	1.26	1.96	Accept H01

Table 5 shows that the t-calculated value (1.26) is less than the t-critical value (1.96) at 0.05 level of significance with 56 degrees of freedom. Therefore, the null hypothesis was accepted, indicating that significant integration of digital technology in chemistry classrooms to enhance student engagement and understanding does not exist in teaching and learning of Chemistry in secondary schools in Mangu LGA.

Hypothesis Two: There are no perceived challenges and benefits of incorporating digital technology in chemistry instruction among secondary school teachers.

Table 6: Summary of t-test on perceived challenges and benefits of incorporating digital technology in chemistry classrooms among secondary school teachers

N	Mean	SD	df	t-cal	t-crit	Decision
18	3.50	0.21	56	1.67	0.96	Reject H02

Table 6 shows that the t-calculated value (1.67) is greater than the t-critical value (0.96) at 0.05 level of significance with 56 degrees of freedom. Therefore, the null hypothesis was rejected, indicating that significant challenges and benefits of incorporating digital technology in chemistry instruction among secondary school teachers exist in Mangu LGA.

Hypothesis Three: Digital simulations and virtual experiments do not impact students' practical skills and experimental understanding in chemistry education.

Table 7: Summary of t-test on impact of Digital simulations and virtual experiments on practical skills and experimental understanding of chemistry students

N	Mean	SD	df	t-cal	t-crit	Decision
18	2.96	0.35	56	1.97	1.45	Reject H03

Table 7 shows that the t-calculated value (1.97) is greater than the t-critical value (1.45) at 0.05 level of significance with 56 degrees of freedom. Therefore, the null hypothesis was rejected, indicating that digital simulations and virtual experiments do impact students' practical skills and experimental understanding in chemistry education in Mangu LGA.

DISCUSSION OF FINDINGS

The study revealed that while chemistry teachers recognize the significant potential of digital technology to enhance student engagement, understanding, and performance in chemistry education, actual implementation remains limited in the studied schools. Research findings identified several key barriers including inadequate power supply (the most significant challenge), high costs of acquiring and maintaining digital devices, expensive internet subscriptions, and software limitations. Despite these obstacles, digital technology was found to offer numerous benefits including improved student performance, increased motivation, more interactive learning experiences, and enhanced information sharing. The study also showed that digital simulations and virtual experiments positively impact students' practical skills by enabling self-paced learning, repe

tition of experiments, and safe exploration of complex chemical processes. These findings align with previous research by scholars such as Akçayır and Akçayır (2017), Andoh (2012), Ali et al (2013), Ziden et al. (2011), and Hand and Treagust (2013). However, a significant gap exists between recognizing the potential benefits of digital technology and its actual integration in chemistry classrooms, consistent with Park's (2011) observation that technical infrastructure, teacher readiness, and institutional support significantly influence technology adoption in educational settings.

5. CONCLUSION

This study investigated the impact of digital technology on teaching and learning of chemistry in selected secondary schools in Mangu LGA of Plateau State. The findings reveal that while there is a high level of agreement among chemistry teachers regarding the positive impact of digital technology on student engagement, understanding, and performance in chemistry, the actual integration of these technologies in chemistry classrooms is limited. Various challenges impede the effective implementation of digital technology in chemistry education, with inadequate power supply being the most significant barrier, followed by the high cost of acquiring and maintaining digital devices and internet services. Despite these challenges, digital technology offers numerous benefits for chemistry education, including enhanced student performance, increased motivation, more interactive learning experiences, and improved information sharing. Furthermore, digital simulations and virtual experiments positively impact students' practical skills and experimental understanding in chemistry, enabling them to learn at their own pace, conduct experiments repeatedly, and explore complex experiments safely. However, the gap between recognizing the potential benefits of digital technology and its actual implementation in chemistry classrooms indicates a need for strategic interventions to address the identified challenges and promote more effective integration of digital technology in chemistry education in Mangu LGA.

6. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Government and educational authorities should prioritize improving infrastructure, particularly power supply, in secondary schools to facilitate the effective integration of digital technology in chemistry education. This could involve investing in alternative power sources such as solar energy systems to ensure reliable electricity for digital devices.
2. School administrators should pursue partnerships with technology companies, non-governmental organizations, and international agencies to secure funding and support for acquiring and maintaining digital devices and resources for chemistry education.
3. Professional development programs should be organized for chemistry teachers to enhance their digital literacy and competence in integrating technology into their teaching practices. These programs should focus on practical applications of digital technology in chemistry education and address teachers' specific needs and concerns.
4. Chemistry curriculum developers should explicitly incorporate digital technology components, including digital simulations and virtual experiments, into the chemistry curriculum to ensure systematic integration of these technologies in teaching and learning processes.
5. Schools should establish collaborative networks among chemistry teachers to facilitate the sharing of digital resources, expertise, and best practices in technology integration, thereby maximizing the benefits of limited resources and fostering a community of practice around digital technology in chemistry education.

References

Abonyi, O. S., Achimugu, L., & Njoku, M. I. (2014). Innovations in science and technology education: A case for ethnoscience-based science classrooms. International Journal of Scientific and Engineering Research, 5(1), 52-56.

Akçayır, M., & Akçayır, G. (2017). Enhancing chemistry education with augmented reality: A review. Journal of Science Education and Technology, 26(1), 127-141. https://doi.org/10.1007/s10956-016-9660-3

Ali, G., Haolader, F. A., & Muhammad, K. (2013). The role of ICT in making teaching-learning effective in higher institutions of learning in Uganda. International Journal of Innovative Research in Science Engineering and Technology, 2(8), 61-73.

Anderson, L. W., & Becker, K. (2017). Teaching chemistry in the digital age: Strategies for incorporating technology. Journal of Chemical Education, 94(3), 317-325. https://doi.org/10.1021/acs.jchemed.6b00687

Andoh, C. B. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. International Journal of Education and Development using Information and Communication Technology, 8(1), 136-155.

Ashley, W. (2016). 10 reasons today's students need technology in the classroom. Retrieved from http://www.Seccuredgenetworks.com/10-Reasons-Todays-students-Need-Technology-in-the-classroom

Aslan, Z., & Dogdu, S. (2016). Educational technology applications and educational instruments. Ankara: Tekisik Offset.

Aslan, Z., & Dogdu, S. (2020). Educational technology applications and educational instruments. Ankara: Tekisik Offset.

Badeleh, A., & Sheela, G. (2011). The effects of information and communication technology based approach and laboratory training model of teaching on achievement and retention in chemistry. Contemporary Educational Technology, 2(3), 213-237.

Carrillo, P., Onofa, M., & Ponce, J. (2010). Information technology and student achievement: Evidence from a randomized experiment in Ecuador. Washington, DC: Inter-American Development Bank.

Chiu, J. L., Delaegher, C. J., & Hong, H. (2017). Investigating the impact of interactive technology on student learning and engagement in high school chemistry classrooms. Journal of Science Education and Technology, 26(3), 269-279. https://doi.org/10.1007/s10956-016-9679-4

Enekwechi, E. E., Okeke, S. O., Nwanze, A. C., & Chikwendu, V. (2019). Effects of concept-mapping and think-pair-share teaching strategies on secondary school students' achievement in chemistry. Science Education International Journal, 30(1), 92-100.

Erinosho, S. Y. (2017). The use of virtual laboratories in organic chemistry: Evaluation of three educational platforms. Education and Information Technologies, 24(2), 1521-1535. https://doi.org/10.1007/s10639-018-9765-2

Fasasi, M. O. (2018). The impacts of an ethnoscience-based teaching strategy on learning outcomes in chemistry. Unpublished Ph.D. thesis, University of Ibadan, Ibadan, Nigeria.

Fitria, Y., & Wisudawati, A. W. (2018). The development of an ethnoscience-based chemical enrichment book as a science literacy source for students. International Journal of Chemistry Education Research, 2(1), 50-59.

Foldoc, J. (2008). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A review of recent research. Educational Technology Research and Development, 65(1), 1-22. https://doi.org/10.1007/s11423-016-9481-2

Haddad, W. D., & Jurich, S. (2018). ICT for education: Potential and potency. In W. D. Haddad & A. Draxler (Eds.), Technologies for education: Potentials, parameters, and prospects (pp. 28-40). Paris: UNESCO and Academy for Educational Development.

Hand, B., & Treagust, D. (2013). Designing and teaching the chemistry curriculum with learnin g technologies. In E. Yuriev, C. Johnstone, & J. K. Gilbert (Eds.), Chemical education: Towards research-based practice (pp. 407-434). Berlin: Springer.
Hertzog, C. (2018). Digital technology in the chemistry classroom: A comprehensive review of educational apps. Chemistry Education Research and Practice, 19(2), 432-447. https://d oi.org/10.1039/c7rp00178a
Hoostrurj (2015). Digital chemistry: The possibilities of the Internet and ICT in chemical educa tion. Chemistry Education Research and Practice, 14(1), 41-57. https://doi.org/10.1039/ C3RP00102D
Indradevi, S. T., & Bitwell, M. C. (2016). The ethnoscience approach in science education. Inte rnational Journal of Scientific and Engineering Research, 4(2), 134-137.
Konyefa, M., & Nwanze, E. (2020). Effects of the problem-based learning approach on senior s econdary school students' achievement in organic chemistry. International Journal of Se condary Education, 8(4), 109-116.
Moore, M. G., & Kearsley, G. (2019). Distance education: A systems view of online learning. B elmont, CA: Wadsworth.
Murphy, M., Broadfoot, K. S., & Johnson, C. (2018). Digital technologies in chemistry educati on: A global perspective. Journal of Chemical Education, 95(8), 1372-1378. https://doi. org/10.1021/acs.jchemed.8b00483
Murray, J. G. (2013). Mobile learning: Two case studies of supporting inquiry learning in infor mal and semiformal settings. Computers & Education, 61, 21-32.
Nwanze, A. C., Izuegbunam, G. A., Pius, K. S., Emerhiona, E. C., & Okoli, J. N. (2018). A soci al-cognitive framework for pedagogical agents as learning companions. Educational Te chnology Research and Development, 64(1), 37-55. https://doi.org/10.1007/s11423-01 5-9405-9
Okoro, C. O., & Ekpo, E. E. (2016). Effects of information and communication technology on s tudents' learning of physics in Uyo Local Government Area, Akwa Ibom State. Internati onal Journal of Scientific Research in Education, 9(2), 87-95.
Okwara, O. K., & Upu, F. T. (2017). Effects of ethno-science instructional approach on student s' achievement and interest in upper basic science and technology in Makurdi Local Gov ernment Area of Benue State. International Journal of Scientific Research in Education, 10(5), 1-8.
Okoli, J. N., & Nwanze, A. C. (2018). Influence of guided-discovery strategy on students' achie vement and interest in chemistry. Journal of STEM Education, 15(2), 5-13.
Oluwatosin, O. B., Emmanuel, B. A., & Peter, O. O. (2017). Development of a teaching method that integrates indigenous scientific knowledge with the teaching of school science. We st African Journal of Open and Flexible Learning, 4(2), 33-44.
Park, S. Y. (2011). An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning. Educational Technology & Society, 14 (2), 16-27.
Poulter, N. R., & Basford, K. E. (2013). ICT for the next generation: The effect of ICT on educa tion performance. International Conference on Education and New Learning Technolog ies, Barcelona, Spain, 1-3 July 2013, 5842-5849.
Ryan, R. M. (2013). The impact of technology on chemistry education. Journal of Chemical Ed ucation, 90(1), 28-31. https://doi.org/10.1021/ed300121t
Safdar, M., Yousuf, M. I., Parveen, Q., & Behlol, M. G. (2011). Effectiveness of information an d communication technology (ICT) in teaching mathematics at the secondary level. Inte rnational Journal of Academic Research, 3(5), 67-72.

Salehi, H., & Salehi, Z. (2012). Integration of ICT in language teaching: Challenges and barrier s. Proceedings of the 3rd International Conference on e-Education, e-Business, e-Mana gement, and e-Learning (IC4E, 2012), IPEDR Vol. 27, 215-219.

Singh, A. (2013). Understanding the relationship between teachers' pedagogical beliefs and tec hnology use in education: A review of recent research. Educational Technology Researc h and Development, 65(1), 1-22. https://doi.org/10.1007/s11423-016-9481-2

Ugwu, A. N., & Diovu, C. I. (2016). Effect of collaborative instructional strategy on students' a chievement in junior secondary school mathematics. Journal of Research in National D evelopment, 14(1), 107-114.

Yusuf, M. O. (2015). Information and communication technology and education: Analyzing the Nigerian national policy for information technology. International Education Journal, 6 (3), 316-321.

Ziden, A. A., Ismail, I., Spian, R., & Kumutha, K. (2011). The effects of ICT use in teaching an d learning on students' achievement in science subjects in a primary school in Malaysia. Malaysian Journal of Distance Education, 13(2), 19-32.