Integration of Emerging Technology in Teaching and Learning of Biology Concepts in Secondary Schools in Akwa Ibom State, Nigeria

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Abstract
The study investigated the integration of emerging technologies in teaching and learning of Biology concepts in secondary schools Akwa Ibom State, Nigeria. three research questions and three hypotheses guided the study. The design of the study was a descriptive survey. The target population were all the 796 Biology teachers in secondary schools in Akwa Ibom State The sample for the study consisted of 300 teachers was used as respondents for this study in the study area. Stratified random sampling technique was adopted in sampling the respondents across the state. Self-developed questionnaire was used as instrument for data collection which was validated by the researcher's supervisor and two other lecturers from Science Education Department. The reliability index of the instrument was done using Cronbach alpha statistics and found to be 0.78. The data collected were analysed using mean and standard deviation to answer research questions and chi-square (X^2) statistical technique to test the hypotheses at 0.05 level of significance. Findings showed that there was a significant difference in levels of awareness, but there was no significant difference in level of competence and perception in the integration of emerging technologies in Akwa Ibom state. Based on the findings it was recommended that particular attention should be devoted to supplying adequate opportunities for the career development of teachers in developing technological competencies, which help them successfully use them in teaching and learning.

Key words: Integration, Emerging Technologies, Teaching and Learning

Introduction

The advancements in computers and computing over the past twenty-five years have been so transformative that it is unsurprising to witness their displacement of other technological teaching aids (Akyuz, 2018). However, this does not imply that we should completely disregard alternative aids or neglect the need to research their effective utilization. Nevertheless, it is evident that the current range of available technologies has significantly broadened the scope, complexity, and sophistication of potential classroom activities. The advent of computer-based technology has also presented numerous new challenges for educators seeking to comprehend its offerings and determine the best way to deliver them to students (Watson, & Rockinson-Szapkiw, 2021).

The widespread prevalence of technology in contemporary society has brought about significant transformations in various domains such as healthcare, education, medicine, entertainment, business, trade and commerce, and leisure. The utilization of technology has become an unavoidable reality in the two decades following the introduction of personal

computers (Duru, Uko, & Utibe, 2024). It was argued that disregarding the changes brought about by technology would be detrimental, particularly for educators.

The rapid advancement in science and technology has made it imperative to incorporate emerging technological tools into the educational setting. The effective utilization of emerging technologies in teaching and learning cannot be overstated, as the educational system has transitioned from an analog environment to a digital world. Numerous technologies have been developed, with many more in the design phase, to complement teachers' pedagogical practices. Schools have also begun integrating technology into classroom instruction, especially during the recent global pandemic, making it essential for all teachers to possess knowledge of technology integration with pedagogy. However, despite the recognition of the importance of technology for effective teaching and learning, the availability and utilization of emerging technological tools remain inadequate in most Nigerian secondary schools. Even in schools where these facilities are present, teachers and students rarely utilize them, and when they do, they often lack the necessary pedagogical knowledge and instructional strategies (Watson, & Rockinson-Szapkiw, 2021). The limited utilization of these various technological tools by teachers can be attributed to factors such as lack of technological knowledge, pedagogical knowledge, skills, abilities, attitudes, and beliefs (Tanak, 2018).

The integration of emerging technologies in teaching and learning is no longer a mere choice but a necessity for educators, given the extensive influence of technology on education, particularly in relation to the evolving learning environment. There is a growing demand for flexibility in teaching methodologies and the need to foster creativity and innovation in learning. The application of emerging technologies has become irresistible in the teaching and learning process, fundamentally altering the structure, organization, and job performance of educators (Yildirim, & Sensoy 2018).

The adoption and integration of emerging technologies facilitate increased interaction between educators and students beyond the traditional classroom setting, allowing for classes to be conducted at any time and place. Emerging technologies not only streamline the teaching and learning process but also enhance the quality of content, interactions, and instructional methods. Hasiloglu *et al.* (2020) assert that Information Technology has become a crucial resource, as its absence can lead to a lack of knowledge, poor decision-making, and ultimately, a poor job performance by teachers. Similarly, Duru *et al.*, (2024) contend that technology holds significant importance across various fields, including education, healthcare, banking, aviation, law, and security and many others.

The integration of emerging technologies, such as Artificial Intelligence (AI), has brought about a transformation in the value chains of creative content throughout the entire process (Hasiloglu *et al.* (2020). WEforum, (2018) assert that the performance of teachers is closely intertwined with the technological advancements they are exposed to Akyuz (2018) holds the belief that technology has a significant impact on employees' performance, leading to increased satisfaction and motivation. Tanak (2018) observes that technologies can only

enhance productivity and improve performance when effectively combined with other resources by human resource personnel or when utilized efficiently. The adoption of emerging technologies by educators is crucial for their job performance and the enhancement of the teaching and learning process, as well as the overall quality of education (Akram, Yingxiu, Al-Adwan, & Alkhalifah, 2021)..

The field of education remains one of the sectors most heavily influenced by technology. Emerging technologies continuously reshape the teaching and learning process, catering to diverse learners, promoting research, improving students' academic performance, and enhancing the job performance of staff. The introduction of emerging technologies has brought about significant changes in the "What," "How," "Where," and "When" of teaching and learning. It enables a more concrete and flexible approach to learning, facilitating better understanding of concepts and accommodating diverse types of learners (Angelo & Michael 2023).

The integration of emerging technologies in the classroom fosters learning motivation, which is crucial for successfully achieving teaching and learning objectives. Additionally, it enhances the performance of teachers in the teaching and learning process and improves students' academic performance. Tanak (2018) contends that organizations acquire advanced technological tools to enhance employee performance, streamline job tasks, improve communication, increase efficiency, and achieve higher levels of effectiveness in work management. Yildirim, and Sensoy (2018) suggest that technology can serve as a tool to assist individuals in enhancing their performance and adapting to changes.

The pedagogical utilization of emerging technologies in the instructional and learning process aids educators in adapting to the changing trends in education (Watson & Rockinson-Szapkiw, 2021). Parry and Battista (2019) posited that emerging technologies assist employees in updating their skills to compete in the forthcoming world of work. This implies that scholars and other professionals should be prepared to innovate by consistently embracing emerging or cutting-edge technologies in order to thrive in their careers and acclimate to the new world of work.

In recent times, a concerted effort has been made to incorporate contemporary technologies into the school curriculum. This endeavour includes providing courses to train teachers in modern technologies such as computers, the internet, multimedia, and communication technologies, as well as the development of suitable educational software (Rifkin, 2017).

When attempting to enhance the integration of emerging technologies for instructional purposes, it is crucial to acknowledge the invaluable role of the classroom teacher. Numerous studies have identified and supported the assertion that teacher beliefs and attitudes significantly influence the integration of emerging technologies into instructional methods (Rifkin, 2017; Redecker, 2023).). While government entities and school administrators may recognize its importance in the classroom, ultimately it is the classroom teacher who determines the most effective way to implement the provided curriculum on a

daily basis. According to Akturk and Ozturk (2019), the use of fitted technology by teachers has a positive effect on students' learning outcomes. While classroom teachers should not be solely blamed for the limited integration of emerging technologies in the classroom, they are the key factor to consider when considering the practical implementation of these technologies for instructional purposes (Wang, Chiang, & Wu, 2017). Given the crucial role of the classroom teacher, adequate professional development is necessary to enhance the integration of emerging technologies in the classroom (Redecker, 2023). Hemant (2018) stated that technology plays a significant role in making teaching and learning activities more meaningful and efficient, and it is one of the most effective tools for advancing knowledge and skills. However, defining and providing "adequate professional development" can pose significant challenges for the majority of schools.

The integration of emerging technology in the teaching and learning of teachers can be understood as the utilization of technology resources in the teaching and learning process (Tondeur, Van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). It involves incorporating technology in the pedagogy to facilitate effective learning (Cabero, & Barroso, 2016; Christensen, & Knezek, 2016). This means that technology used in teaching and learning is not limited to data searching but also encompasses the use of emerging technologies in schools to enhance the quality of teaching and the methods employed by teachers, as well as to facilitate learning and educational development. It entails the appropriate, regular, and regulated use of interactive technologies that bring about beneficial changes in school practices and student learning. According to Patrick (2018), emerging technologies revolutionize the way students and teachers work and interact, aiming to make learning more efficient, engaging, and enjoyable, thereby attracting both students and the universities they enrol in. Nonetheless, despite the perceived positive effects of emerging technologies, their integration in the teaching and learning process is still hindered by various factors that the present study seeks to examine (Diane, & Steven, 2017; Onyema, 2020; Enang, 2022).

Against the backdrop of perceiving emerging technologies as a means of instructional delivery in the teaching and learning within secondary schools, this study is conceived. Consequently, this study seeks to establish the levels of awareness, competence in use and perception of integrating emerging technologies in the teaching and learning of Biology concepts within secondary schools.

This study is anchored on the Davis's Technology Acceptance Model (1989) theory of learning or TAM, posits that there are two factors that determine whether a computer system will be accepted by its potential users: (1) perceived usefulness, and (2) perceived ease of use. The key feature of this model is its emphasis on the perceptions of the potential user. This original inception of the Technology Acceptance Model stated that the goal of this theory was to "provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified". The use of the Technology Acceptance Model has since been

expanded to include various other technologies beyond computers, including use of telemedicine services, digital technologies for teachers, phone apps, and e-learning platforms for students.

Statement of the Problem

As part of the efforts to ensure Nigeria's educational sector is at par with global standards, stakeholders in Nigeria's education sector have urged the Federal Government to include emerging technologies, in school's curricula across the country. They pointed out that, if adopted for teaching learning process, it would adequately make for an easy learning experience for the learners and make teaching on the part of teachers easy and dynamic. The Nigerian education system has suffered from a lot of setbacks. A beautiful curriculum will be designed but it will crash at the point of implementation. Stakeholders have started to urge the Federal Government of Nigeria to incorporate emerging technology in the curriculum.

From the aforementioned, Biology teachers are expected to be aware, have some level of competencies and a positive perspective towards emerging technology to be able to integrate same. Hence, this study seeks to ascertain the level of teachers' and students' awareness of emerging technologies, teachers and students' competence in use and teachers' and students' perception towards emerging technologies in Akwa Ibom State.

Purpose of Study

The main purpose of this study was to investigate the influence of the integration of emerging technologies in teaching and learning of teachers' of Biology concepts in Akwa Ibom state. Specifically, the study investigated the;

1. Level of awareness of teachers to emerging technology for teaching and learning of Biology concepts in secondary schools
2. Level of teachers' competence in the use of emerging technology for teaching and learning of Biology concepts in secondary schools
3. Teachers' perception towards emerging technologies for teaching and learning of Biology concepts in secondary schools

Research Questions

The following questions will be answered to guide the study;

1. What is the level of awareness of teachers to emerging technology for teaching and learning of Biology concepts in secondary schools?
2. What is the level of teachers' competence in the use of emerging technology for teaching and learning of Biology concepts in secondary schools?
3. What is the teachers' perception towards emerging technologies for teaching and learning of Biology concepts in secondary schools?

Hypotheses

The following null hypotheses were formulated for the studies;

1. There is no significant difference in the level of awareness of teachers to emergent technology for teaching and learning of Biology concepts in secondary schools

2. There is no significant difference in the level of teachers' competence in the use of emerging technology for teaching and learning of Biology concepts in secondary schools
3. There is no significant difference in the teachers' perception towards emerging technologies for teaching and learning of Biology concepts in secondary schools

Methodology

This study adopted the descriptive survey research design. It is a design which describes the present condition of a particular situation by collecting and analysing data from a representative sample considered for the entire subjects or the entire population. The target population were all the 796 Biology teachers in secondary schools in Akwa Ibom State. But a sample size of 300 teachers was used as respondents for this study. Stratified random sampling technique was adopted in sampling the respondents across the state. The researcher used self-developed questionnaire as the instrument for data collection which consists of items arranged systematically based on the research questions to collect data and information from level of awareness of teachers' integration of emerging technologies in teaching and learning, level of teachers' competence in integration of emerging technologies in teaching and learning and teachers perception of integration of emerging technologies in teaching and learning. In carrying out this research, data were collected using the integration of emerging technologies in teaching learning Questionnaire (IETTLQ).

The instrument is a structured questionnaire that featured section A, B, C and D. Section A was used to collect information on respondent bio-data such as gender, name of school, length of service and academic qualification. Section B of the questionnaire contained six (6) item statements on teachers' awareness, while section C contained five (5) items statement on teachers' competence in use and section D contained five (5) items statement on teachers' perception each developed on a 4-point rating scale. The respondents were expected to tick appropriate option in the space that was provided in front of each item. These options were Very High Level (VHL), High Level (HL), Moderate Level (ML) and Low Level (LL) for Awareness and Competence of the integration of emerging technologies in teaching learning while Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) for Teacher Perception of the integration of emerging technologies in teaching and learning The teachers were required to indicate which choice that best represented their interest.

The instrument was duly validated and subjected to Cronbach Alpha statistics to obtain the reliability coefficient of 0.78. The data collected were analysed using mean and standard deviation to answer research questions and chi-square statistics to test the hypothesis at 0.05 level of significance.

Decision Rule

Levels of Awareness and Competence

Very high level	3.50-4.00
High level	2.50-3.49
Moderate level	1.50-2.49
Low level	1.00-1.49

Teachers Perception

Strongly Agree (SA),	3.50-400
Agree (A),	2.50-3.49
Disagree (D)	1.50-2.49
Strongly Disagree (SD).	1.00-1.49

Results

Results are presented in tables based on the research questions and hypotheses that guided the study.

Answering of Research Questions

Research Question 1: What is the level of awareness of teachers to emerging technology for teaching and learning of Biology concepts?

The result of this analysis is presented in Table 1.

Table 1: Level of awareness of teachers to emerging technology for teaching and learning of Biology Concepts

S/N	Level of awareness	Mean	SD	Remark
1.	Teachers are aware that emerging technologies can improve the teaching-learning process	3.50	.78	VHL
2.	I am aware of the use: i. wearable technologies ii. Virtual reality iii. Mobile devices	3.23	.76	HL
3.	Teaching using emerging technologies makes me to teach better	1.83	.65	ML
4.	I am aware that the use of emerging technologies in teaching leads to greater students involvement in teaching and learning process	3.36	.62	HL
5.	Teaching using emerging technologies makes me a better teacher	3.22	.75	HL
6.	Using emerging technologies can improve my teaching	3.35	.63	HL

Data in Table 1 showed that item 1with mean rating ranging from 3.50 to 4.00 noticed a very high level of awareness that emerging technologies can improve the teaching-learning process of Biology concepts. Also, items 2, 4, 5 and 6 with mean rating ranging from 2.50-3.49 noticed a high level of awareness in the use of emerging technologies in teaching-learning of Biology concepts while item 3 with mean rating ranging from 1.50 to

2.49 noticed a moderate level of awareness in emerging technologies in teaching-learning of Biology concepts.

Research Question 2: What is the level of teachers' competence in the use of emerging technology for teaching and learning of Biology concepts

Table 2: Level of teachers' competence in the use of emerging technology for teaching and learning of Biology Concepts

S/N	Level of competence	Mean	SD	Remark
1.	I can create content using collaboration tools to share documents for teaching in a given platform	3.30	.72	HL
2.	I can search for information in the Internet for teaching using a search engine	1.86	.64	ML
3.	Many teachers have the appropriate skills and knowledge regarding the effective use of emerging technologies in teaching	3.60	.78	VHL
4.	I can communicate with other users via chat - using basic functions for teaching	1.93	.68	ML
5.	Teachers know that not all information on the network is reliable for use in teaching	2.40	.71	ML

Data in Table 2 showed that item 3 with mean rating ranging from 3.50 to 4.00 noticed a very high level of competence that many teachers have the appropriate skills and knowledge regarding the effective use of emerging technologies in teaching of Biology concepts. Also, items 2, 4, and 5 with means rating ranging from 1.50-2.49 noticed a moderate level of competence in search for information in the internet for teaching using a search engine; communicate with other users via chat using basic functions for teaching; and teachers knowing that not all information on the network is reliable for use in teaching of Biology concepts while item 1 with mean rating ranging from 2.50 to 3.49 noticed a high level of competence in creating content using collaboration tools to share documents for teaching in a given platform.

Research Question 3: What is the teachers' perception towards emerging technologies for teaching and learning of Biology Concepts?

Table 3: Teachers' perception towards emerging technologies for teaching and learning of Biology Concepts

S/N	Teachers Perception	Mean	SD	Remark
1.	The teachers belief that the integration of emerging technologies in teaching and learning can keep learners motivated	3.34	.73	A
2.	The teachers are willing to integrate emerging	3.23	.75	A

	technologies for teaching and learning			
3.	The teachers are perceive integration of emerging technologies for teaching and learning is exciting.	2.23	.71	D
4.	Teachers believe that integration of emerging technologies in teaching assists them in enhancing their instructional practices	3.20	.76	A
5.	Teachers believe that integration of emerging technologies for teaching and learning is attainable	3.50	.78	SA

Data in Table 3 showed that item 5 had mean ratings ranging from 3.50 to 4.00 strongly agreed that teachers believe that integration of emerging technologies for teaching and learning is attainable. Also, items 1, 2, and 4 with means rating ranging from 2.50 to 3.49 agreed that teachers' belief that the integration of emerging technologies in teaching and learning can keep learners motivated; teachers are willing to integrate emerging technologies for teaching and learning; teachers believe that integration of emerging technologies in teaching assists them in enhancing their instructional practices in Biology concepts while item 3 with mean rating ranging from 1.50 to 2.49 disagreed that teachers are perceived integration of emerging technologies for teaching and learning is exciting.

Testing the Hypotheses

Hypothesis 1: There is no significant difference in the level of awareness of teachers to emerging technology for teaching and learning of Biology Concepts

Table 4: Chi square analysis of the level of awareness of teachers to emerging technology for teaching and learning of Biology Concepts

	Value	df	Asymp. Sig. (2 sided)
Pearson Chi-Square	62.621[a]	1	.000
Likelihood Ratio	56.422	1	.000
Linear-by Linear Association	1.106	1	.000
No of Valid Cases	300		

The result in Table 4, showed that the calculated value (62.621) has probability significant value of 0.000 which is less than the desirable level of significance (α) value of 0.05. Since the probability significant level of 0.000 is less than the alpha level of significance 0.05 therefore the hypothesis one is rejected. That is there is a significant difference in the level of awareness of teachers to emergent technology for teaching and learning of Biology concepts

Hypothesis 2: There is no significant difference in the level of teachers' competence in the use of emerging technology for teaching and learning of Biology Concepts.

Table 5: Chi square analysis of the level of teachers' competence in the use of emerging technology teaching and learning of Biology Concepts

	Value	df	Asymp. Sig..(2-sided)
Pearson Chi-Square	450.208[a]	1	.000
Likelihood Ratio	512.082	1	.000
Linear-by-Linear Association	138.568	1	.000
No of Valid Cases	300		

Results in Table 5, showed that the calculated value (450.208) has probability significant value of 0.000 which is less than the desirable level of significance (α) value of 0.05.Since the probability significant level of 0.000 is less than the alpha level of significance 0.05 therefore the hypothesis two is rejected. That is, there is a significant difference in the level of teachers' competence in the use of emerging technology for teaching and learning of Biology concepts.

Hypothesis 3: There is no significant difference in the teachers' perception towards emerging technologies for teaching and learning of Biology concepts

Table 6: Chi square analysis of Teachers' perception towards emerging technologies for teaching and learning of Biology concepts

	Value	df	Asymp. Sig. (2 sided)
Pearson Chi-Square	17.678[a]	1	.116
Likelihood Ratio	16.156	1	.068
Linear-by-Linear Association	21.353	1	.062
No of Valid Cases	300		

Results in Table 6, showed that the calculated value (17.678) has probability significant value of 0.116 which is greater than the alpha level of significance (α) value of 0.05**.** Since the probability significant level of 0.116 is greater than the alpha level of significance 0.05 therefore the hypothesis three was accepted. That is there is no significant difference in the teachers' perception towards emerging technologies for teaching and learning of Biology concepts.

Summary of Findings

The results of data analysis displayed in Tables 1 – 6 yielded the following findings

1. There is a significant difference in the level of awareness of teachers to emerging technology for teaching and learning of Biology concepts in secondary schools.
2. There is a significant difference in the level of teachers' competence in the use of emerging technology for teaching and learning of Biology concepts in secondary schools.
3. There is no significant difference in the teachers' perception towards emerging technologies for teaching and learning of Biology concepts secondary schools.

Discussion of Findings

In this section, the results of the findings are discussed according to the research questions and hypotheses as itemized thus

Level of Awareness of Teachers to Emerging Technology for Teaching and Learning of Biology concepts

The findings of the study on level of awareness of teachers to emerging technology for teaching and learning of Biology concepts in secondary schools showed that there is a significant difference in the level of awareness of teachers to emerging technology for teaching and learning in secondary schools in secondary schools. This could be attributed to teachers' experience during the Covid-19 era. This agrees with Abba and Adamu (2019) who noted that awareness entails teachers' ability to know about Internet services and other technological tools that can be used in carrying out academic activities. Integration of technology in the teaching and learning cannot be underscored due to its relevance in the current world of science and technology.

Level of Teachers' Competence in the use of Emerging Technologies of Biology concepts

The findings on level of teachers' competence in the use of emerging technology for teaching and learning Biology concepts in secondary schools showed that there is a significant difference in the level of teachers' competence in the use of emerging technology for teaching and learning in secondary schools. The findings of this study agrees with Walan (2020) in a study to investigate what happens in science classrooms when teaching is almost entirely based on the use of digital technology. Findings showed that the science teachers' general approach in the classroom revealed that they were self-confident in using digital technology, and utilised predetermined digital study material and, when it was felt necessary. The teachers claimed that digital technology had improved their teaching, providing more breadth because of access to varied digital tools; teaching had also become more individualised. This can be attributed to the fact that teachers were positive about using digital technology since they thought it motivated their students and made assessment easier.

Teachers' Perception towards Emerging Technologies for Teaching and Learning Biology concepts

Findings on the teachers' perception towards emerging technologies for teaching and learning Biology concepts in secondary schools showed that there is no significant difference in teachers' perception towards emerging technologies for teaching and learning secondary schools. The finding of this study is in line with Akram, *et al.*, (2022) in a study on teachers' perceptions of technology integration in teaching-learning practices: A systematic review. Findings showed that teachers exhibit positive perceptions regarding technology integration in teaching-learning practices. They believe that technology-incorporated teaching assists them in enhancing their instructional practices effectively, making the learning process exciting and interactive, and keeping learners motivated.

Conclusion

The result of this study highlighted the levels of awareness, competence in use and perception of the integration of emerging technologies in secondary school teaching and learning of Biology concepts. The sample was secondary schools in Akwa Ibom State. Based on the findings of this study, it was concluded that there is a significant difference in awareness and level of competence of teachers to integrating of emergent technology in teaching and learning of Biology concepts. The level of their perception of integrating emergent technologies is not significant.

Educational Implications of the Findings

1. The implication of this study suggests that teachers need to be aware of the available emerging technologies that can be harnessed for teaching and learning
2. Teachers need to be trained and re-trained on the use of integrating emerging technologies to ensure competence in use
3. Findings also implied that teachers' level of perception of the integration of emerging technologies can change when they are engaged

Recommendations

Based on the findings, it was recommended that;

1. Particular attention should be devoted to supplying adequate opportunities for the career development of teachers in developing technological competencies, which help them successfully use ICT in their instructional practices.
2. There should be a periodic training and retraining of teachers to update their knowledge on learning technologies
3. Educational institutions should ensure the provision of relevant infrastructures to facilitate the adoption and integration of emerging educational technologies
4. There should be an increased budgetary allocation for educational institutions to improve their capacity to acquire, implement, upgrade and maintain emerging technologies by government and other agencies.

5. Educational institutions should establish department of learning technologies to enhance innovations and research on education technology.

Reference

Abba, T., & Adamu, A. L. G. (2019). University lecturers' level of awareness and proficiency of internet services and resources for academic activities in Adamawa state of Nigeria. Library Philosophy and Practice. https://www.digitalcommons.unl.edu

Akram H, Abdelrady AH, Al-Adwan AS & Ramzan M (2022). Teachers' perceptions of technology integration in teaching-learning practices: A systematic review. *Frontier Psychology*. 13, 1-9

Akyuz, D. (2018). Measuring technological pedagogical content knowledge (TPACK) through performance assessment. *Computers & Education,* 125, 212-225.

Akturk, A. O., & Ozturk, H. S. (2019). Teachers' TPACK levels and students' self-efficacy as predictors of students' academic achievement. *International Journal of Research in Education and Science (IJRES), 5(1), 283-294.*

Akram, H., Yingxiu, Y., Al-Adwan, A. S., & Alkhalifah, A. (2021). Technology integration in higher education during COVID-19: an assessment of online teaching competencies through technological pedagogical content knowledge model. *Frontier Psychology.* 12:736522. doi: 10.3389/fpsyg.2021.736522

Angelo Young & Michael B. Sauter, (2023). Technology: 21 of the most important inventions in the 21st century so far, *USA Today: Money*, Retrieved on 16th November, 2023.

Cabero, J., & Barroso, J. (2016). ICT teacher training: A view of the TPACK model/Formación del profesorado en TIC: Una visión del modelo TPACK. *Cultura y educación*, *28*(3), 633–663. https://doi.org/10.1080/ 11356405.2016.1203526

Christensen, R., & Knezek, G. (2016). Validating the technology proficiency self-assessment questionnaire for 21st century learning. *Journal of Digital Learning in Teacher Education*, *33*(1), 20–31.

Diane, J. K. & Steven, M. N. (2017). Emerging technologies in education and training: Applications for the laboratory animal science community. *ILAR Journal*, *48* (2), 163-169.

Duru, C. M., Uko, P. J & Utibe, U. J. (2024). Application of DNA animation, improvised model and realia in teaching and students' performance based on gender in Biology in Akwa Ibom State, Nigeria. *African Journal of Educational Foundations, 5*(1), 75-92

Enang, C. E. (2022). Emerging technologies in teaching and learning of business education programmes in the new normal in tertiary institution in Nigeria. *Nigerian Journal of Business Education,* 9 (2), 1-15

Hasiloglu, M. A., Calhan, H. S. & Ustaoglu, M. E. (2020). Determining the Views of the secondary school science teachers about the use of social media in education. *Journal of Science Education and Technology*. https://doi.org/10.1007/s10956-020-09820-0

Hemant, D. (2018). Opportunities and challenges to use ICT in government school education of Nepal. *International Journal of Innovative Research in Computer and Communication Engineering*. 6, (4), 3215-3220.

Onyema, E. M. (2020). Integration of emerging technologies in teaching and learning process in Nigeria: The challenges. *Central Asian Journal of Mathematical Theory and Computer Sciences,* 1 (1), 34-39

Parry E. & Battista V. (2019). The impact of emerging technologies on work: a review of the evidence and implications for the human resource function. *Emerald Open Research*, 1(5), 1- 13

Patrick, G. Y. (2018). Emerging technologies in higher education: A case study for putting learning first. Retrieved from Online via www. Education.cu-portland.edu on 15th November, 2023

Redecker, C. (2023). Digital competencies and 21st century skills of university teachers. *European framework for the digital,* 1 (2), 1-22

Rifkin, J. (2017). *Office of Jeremy Rifkin. Archived from the original on February 25, 2017.* Retrieved 18the November, 2023.

Tanak, A. (2018). Designing TPACK-based course for preparing student teachers to teach science with technological pedagogical content knowledge. *Kasetsart Journal of Social Sciences,* 41, 53-59.

Tondeur, J., Van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in

education: a systematic review of qualitative evidence. *Educational. Technology, Research Development.* 65, 555–575. doi: 10.1007/s11423-016-9481-2

Walan, S. (2020). Embracing digital technology in science classrooms—secondary school teachers' enacted teaching and reflections on practice. *Journal of Science Education and Technology*, 2(9), 431–441

Wang, P. H., Chiang, S. T., & Wu, P. L. (2017). Learning experience from an emerging technology integrated curriculum. *International Journal of scientific research and management,* 2 (1), 23-34

Watson, J. H., and Rockinson-Szapkiw, A. (2021). Predicting preservice teachers' intention to use technology-enabled learning. *Comp. Edu.* 168,104- 207.

WEforum in collaboration with McKinsey & Company (2018). *White paper on creative disruption*: The impact of emerge ng technologies on the creative economy. World Economic Forum, Geneva Switzerland. Accessed from Online via www.weforum.org 16th Novemeber, 2023.

Yildirim, H. I. & Sensoy O. (2018). Effect of science teaching enriched with technological practices on attitudes of secondary school 7th grade students towards science course. *Universal Journal of Educational Research*, 6(5), 947-959.