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IMPACTFUL EDUCATIONAL TECHNOLOGY PEDAGOGY IN THE POST-COVID ERA ON STUDENTS' LEARNING STYLES FOR SUSTAINABLE EDUCATION AMONG TERTIARY INSTITUTIONS IN SOKOTO STATE, NIGERIA

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Abstract

This paper highlighted the Impactful of Educational Technology Pedagogy on students' learning styles for achieving Sustainable Education in tertiary institutions within Sokoto State Nigeria, in the post-Covid era. The study investigates how EdTech has transformed teaching methods, shifting from traditional lecture-based approaches to more interactive, student-centered strategies such as flipped classrooms and virtual learning environments. It aims to identify the effects of these technological interventions on different learning styles namely, Active, Reflective, Verbal, and Visual and their contribution to sustainable learning. The research employed a descriptive research with cross sectional design and the study population consisting of 200 level studentsfrom faculty of Education universities in Sokoto State. A sample of 352 students was selected using a stratified random sampling method. Data collection instruments included the Index of Learning Styles (ILS) questionnaire, which assessed students' learning styles, and a researcher-developed questionnaire on Educational Technology Pedagogy. The instrument's reliability was confirmed with a Cronbach Alpha value of 0.87, indicating its reliability. Data analysis encompassed descriptive statistics and Multivariate Analysis of Variance (MANOVA). The findings revealed that Educational Technology Pedagogy had a positive impact in the post-Covid era, particularly on Active and Reflective learning styles, contributing to Sustainable learning in Sokoto State's tertiary institutions. Active learners demonstrated an affinity for collaborative learning, engaging in online forums, asynchronous learning, customized problem-solving, hands-on activities, and critical thinking. Reflective learners, on the other hand, favour synchronous learning, emphasizing skill development, fostering autonomy in thought generation, and encouraging critical thinking. The research recommends that Universities should provide students with access to diverse educational technology resources that supporttheir preferred learning styles.

Keywords: *Educational Technology Pedagogy, Learning Styles and Sustainable learning*

Introduction

In the aftermath of the COVID-19 pandemic, educational institutions around the world have faced the challenge of adapting to a new normal. In order to ensure that students and their learning environments remain safe and effective, many schools and universities had to rapidly transition from an in-person to an online learning system. This transition is not without its challenges; a significant obstacle is the difficulty of maintaining meaningful connections between teachers and students in the virtual classroom, as well as finding effective ways to deliver course material to students who might not be able to attend remote classes (Gross, 2020). To address this challenge, many teachers have adopted to educational technology pedagogy strategies as a way to make remote learning more accessible and impactful. This made educational institutions resorted to distance learning, utilizing online learning platforms and virtual classrooms to facilitate learning. Through the examination of existing literature and studies Cantrell&Collins(2020). The coronavirus pandemic of 2020 drastically changed the landscape of education, forcing educators to rethink their approaches, leverage technology, and make the learning process sustainable.

The pandemic has caused educational institutions around the world to adopt a variety of online teaching methods to ensure continuity of learning. This has necessitated the exploration of the impactful Educational Technology pedagogical approaches that could facilitate sustainable education in the Post-Covidera.

Educational Technology pedagogy has caused a paradigm shift from the traditional lecture-style teaching to interactive student-centered approaches such as flipped classrooms and virtual classrooms (Lee et al., 2020). Research has shown that technology-enhanced instruction has been associated with improved student engagement, motivation, and learning outcomes (Heun et al., 2019).

Moreover, students have reported positive experiences and more meaningful learning when using educational technology (Jones et al., 2018). The impact of educational technology pedagogy on students' learning styles in the Post-Covidera. It is evident that technology has been beneficial in catering to the various needs of learners within the classroom, especially those with diverse learning styles (Watson et al., 2021). Educational technology has opened up the opportunity for personalized learning, allowing teachers to differentiate instruction and provide individualized support in order to meet the learning needs of all students (Williams et al., 2020). The purpose of this study was to investigate the impact of Educational Technology pedagogy in the in the Post-Covid era and students' learning styles for sustainable education.

In conclusion, the impact of educational technology pedagogy on students' learning styles is crucial for educators and policymakers. The transition from traditional, lecture-based instruction to technology-driven, interactive learning environments has reshaped the educational landscape. Technologies such as flipped classrooms, virtual learning environments, and online collaborative tools have not only altered how content is delivered but also how students engage with that content. These changes have been particularly significant in accommodating the diverse learning styles of students, providing opportunities for more personalized and effective learning experiences. As we move further into the Post-Covid era, it is essential to examine how these technological advancements have influenced students' learning preferences and outcomes.

Educational Technology is considered as an academic discipline and an area of study. In recent years, educational technology has advanced at a rapid rate and become afast-growing science committed to converting raw-hand teachers into really effective and efficient ones by equipping them with 21st century practical teaching skills thatis real, easier, better and more effective. In order to accommodate the nature of our learners learning styles today whom globally are often called digital-age learners always with their smart phones. Educational technology focus on the *process of applying tools* for educational purposes as well as *the tools and materialsused*. Educational Technology is a combination of the processes and tools involved in addressing educational needs and problems with an emphasis on applying the most current tools: computers and their related technologiesRoblyer and Edwards (2000).

Learning Styles is the particular and different way of perceiving and organizing information Woolfolk (2000). A learning style can be strengthened by proportional strategies and techniques of learning and teaching. Some researchers suggest that learning style refers to an individual way of gaining, absorbing, acquisition processing, storing, and retaining information Garzottoet al., (2004).The word "learning style" refers to the process

by which the learner organizes, processes, represents, and combines this information and stores it in his cognitive source, then retrieves the information and experiences in the style that reflects his technique of communicating them Jaleel & Thomas, (2019). The concept of learning style is founded based on the fact that students vary in their styles of receiving knowledge and thought, to help them recognizing and combining information in their mind, as well as acquire experiences and skills Naqeeb (2011). Knowledge of learning styles can help educators to expand their teaching techniques to accommodate a variety of students' styles (Mbaegbu, 2012). Learning styles is characteristic cognitive, effective, and psychosocial behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment (Cook, 2005).

Therefore, learning styles play a significant role in the lives of learners. When students recognize their own learning styles, they will be able to integrate into their learning process. As a result, learning process will be easier, faster, and more successful.

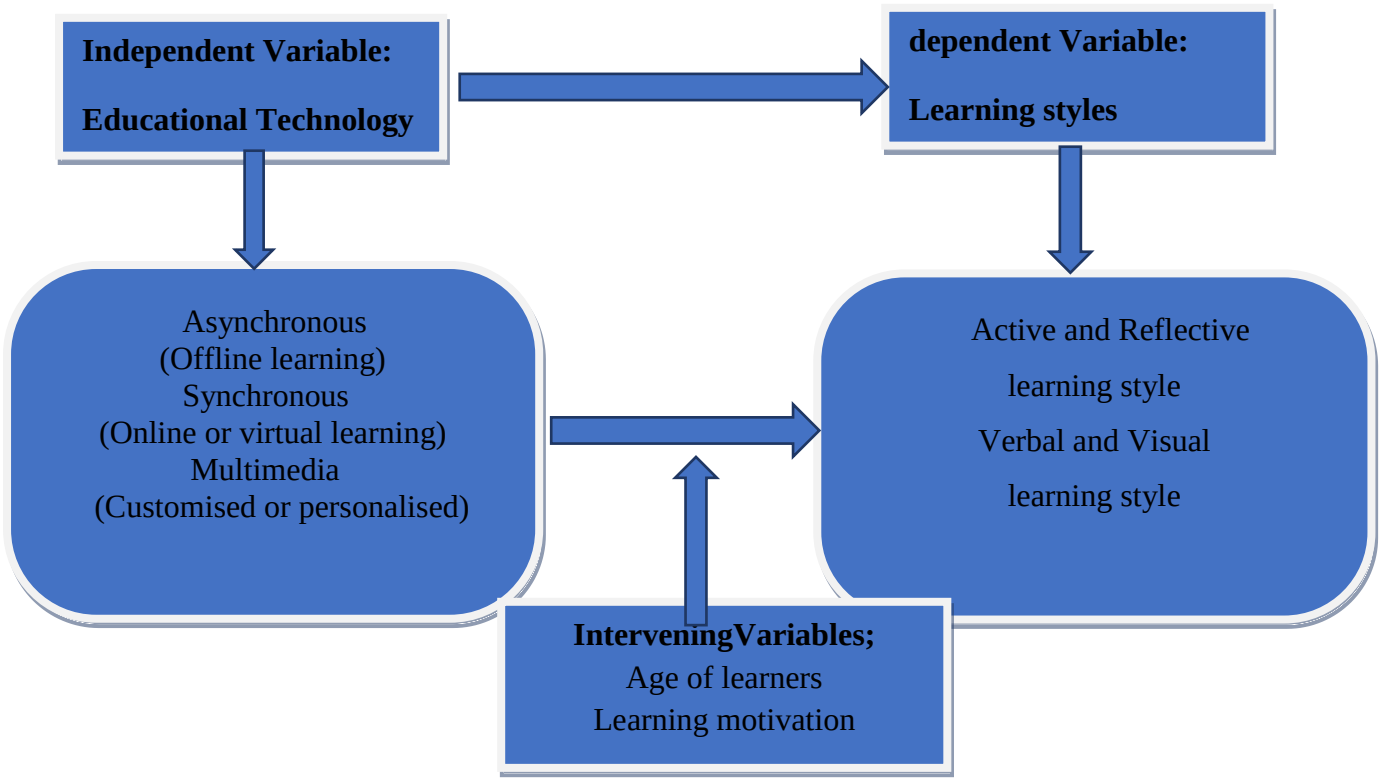
Objectives of the study

1. To find out the impact of educational technology pedagogy in the Post-Covid era between Active and Reflective learning styles for Sustainable Education among tertiary institutions in Sokoto state.
2. To determine the impact of educational technology pedagogy in the Post-Covid era between Active and Reflective learning styles for Sustainable Education among tertiary institutions in Sokoto state.
3. To analysis level of educational technology pedagogy impact in the Post-Covid 19 era between Active and Reflective learning styles for Sustainable learning among tertiary institutions in Sokoto state.
4. To find out the level of significant of educational technology pedagogy impact in the Post-Covid 19 era between Verbal and Visual learning styles for Sustainable learning among tertiary institutions in Sokoto state.

Research Questions

1. What is the impact of educational technology pedagogy in the post-Covid era between Active and Reflective learning styles for Sustainable learning among tertiary institutions in Sokoto state?
2. What is the impact of educational technology pedagogy in the Post-Covid era between Verbal and Visual learning styles for Sustainable learning among tertiary institutions in Sokoto state?
3. What is the level of educational technology pedagogy impact in the Post-Covid 19 erabetween Active and Reflective learning styles for Sustainable learning among tertiary institutions in Sokoto state?
4. What is the level of significant of educational technology pedagogy impact in the Post-Covid 19 erabetween Verbal and Visual learning styles for Sustainable learning among tertiary institutions in Sokoto state?

Conceptual Framework



Source*:* Researcher Designed Model 2023

Literature Review

Introduction

Educational technology pedagogy is becoming a more and more essential aspect of contemporary teaching and learning settings. To promote sustainable learning among tertiary institutions in Sokoto State, Nigeria, the integration of educational technology into pedagogy is essential for fostering sustainable education. This literature review examines the impact of educational technology pedagogy on students' learning styles and its potential for achieving sustainable education in tertiary institutions within Sokoto State.

Impact of Educational Technology Pedagogy on Learning Styles

Educational technology significantly influences students' learning styles by offering diverse tools and resources that cater to various preferences and needs. According to Al-Faki and Khamis (2014), the use of educational technology enhances the learning experience by providing interactive and engaging content, which supports different learning styles such as visual, auditory, and kinesthetic. For instance, visual learners benefit from multimedia presentations, while auditory learners gain from podcasts and audio resources. Kinesthetic learners, on the other hand, engage with simulations and interactive activities that promote active learning.

Moreover, research by Olojo, et. al., (2012) indicates that educational technology enables personalized learning experiences, allowing students to progress at their own pace and according to their unique learning preferences. This adaptability is particularly crucial in a diverse educational setting like SokotoState tertiary institutions, where students may have varied backgrounds and learning needs. By accommodating these differences, educational technology helps create a more inclusive learning environment that supports the academic success of all students. Additionally, it has been suggested that the use of educational technology in the post-COVID-19 era can help to ensure the continuity of learning among schools and universities

(Sattar, 2020). By transitioning to a largely online learning system, educational institutions are able to continue providing students with quality instruction and access to educational resources despite the barriers imposed by the pandemic. Moreover, the use of digital tools can provide teachers with the capacity to better cater to students' individual needs and to better manage the learning environment (Lefkowitz, 2020).

Educational Technology and Sustainable Education

The concept of sustainable education emphasizes the need for education systems to be adaptable, inclusive, and capable of equipping students with the skills necessary for lifelong learning and responsible citizenship (Sterling, 2010). In this regard, educational technology plays a pivotal role in promoting sustainable education by providing flexible learning opportunities that transcend the limitations of traditional classroom settings.

In Sokoto State, the integration of educational technology in tertiary institutions has the potential to enhance the quality of education and contribute to sustainability goals. As noted by Yusuf and Balogun (2011), the use of technology in education promotes critical thinking, creativity, and problem-solving skills, which are essential for students to thrive in a rapidly changing world. Additionally, the accessibility of online resources and digital tools allows for continuous learning beyond the classroom, fostering a culture of lifelong learning.

Challenges and Opportunities among Tertiary Institutions in Sokoto State

Despite the benefits, there are challenges associated with the implementation of educational technology pedagogy in Sokoto State. These challenges include inadequate infrastructure, limited access to technology, and a lack of trained personnel to effectively integrate technology into teaching practices (Garba, 2023). However, there are also significant opportunities for improvement. As suggested by Garba (2023), investing in teacher training, improving technological infrastructure, and promoting the use of open educational resources (OER) can enhance the impact of educational technology on students' learning outcomes.

Research Design

The study used a cross-sectional survey design since it requires the gathering of data from multiple cases at one time, and the researcher selected quantitative research as a method because the study outcomes are statistical data in nature (Amin as cited in Garba, 2023). This approach is efficient for gathering a snapshot of current conditions, opinions, or behaviors across a diverse group of participants, making it ideal for studies that aim to identify patterns or correlations among variables.

The choice of quantitative research as the methodological approach is also appropriate, particularly given that the study outcomes are meantto be statistical in nature. Quantitative research focuses on numerical data, allowing the researcher to apply statistical techniques to analyze and interpret the results. This method is beneficial when the research objective is to quantify variables and determine relationships or trends within the collected data.

Population of the study

The population of the study comprised of 200 level students of Faculty of Education in Tertiary institutions in Sokoto State. The table 1 depicted the total population in the respective schools.

Table 1: Population of the study

S/N	Name of Schools	Population
1	Usmanu Danfodiyo University, Sokoto	2000
2	Sokoto State University	500
3	ShehuShagari University of Education, Sokoto	1450
4	North West University, Sokoto	300
5	ShehuShagari College of Education, Sokoto	600

(Academic registrar record, 2023) from which population of the study was drawn.

Sampling Technique

Purposive sampling technique was adopted because it is more convenient for the research, where the researcher selected twouniversitiesamong the tertiary institutions in Sokoto State from the study population making a total of two Universities sampled for this study. The reason is that some of the Tertiary institutions in Sokoto are yet to get National Universities Commission (NUC)'s approval of the running courses like Education, Instructional Technology and Educational Media and Technology that deal with Educational Technology Nevertheless, at least, one Federal University and one State University was sampled out of five (5) tertiary institutions in State. The purposive sampling technique allowed the researcher, to select a sample that is convenient to study. Usmanu Danfodiyo University, Sokoto and Sokoto State University, was purposely drawn from Tertiary institutions in Sokoto State.

Table 2: Sample size

S/N	Names of School	Population	Sample Size	Sampling Techniques
1	UDUS	2000	327	Simple Random Sampling
2	SSU	500	217	Simple Random Sampling
	TOTAL	**2500**	**352**	

Source: Field data, 2023

Table 2: Indicated sample size used in this study. The study used Research Advisor (2006) to arrive at the sample size above. UDUS population was200 level student of the Faculty of Educationa sample of 327 students' respondents will be targeted and SSU Population of 500 students from the faculty of Education a sample of 217.

Instrumentation

The Index of Learning Styles (ILS) questionnaire was adopted to assess students' learning styles. In addition; a number of questions was developed by the researcher to gather information about Educational Technology Pedagogy in Tertiary Institution in Sokoto and their BIO DATA.

Validity of instrument

The expert rate each item on a scale and their recommendation was used to finally modify questions. Academic staffs were given the questionnaires to examine whether the questionnaire was obtaining the data purposefully designed for by researcher. The content validity index (CVI) was computed as n/N; where n was the number of items which was declared relevant by the academic staffs while N was the total number of items in the instrument.

$$\text{CVI} = \frac{\text{Agreed items by both judges as suitable}}{\text{Total number of items in the questionnaire}} = \frac{34}{39} = 0.87$$

For the instrument to be accepted as valid, average index should be 0.5 or above (Amin, 2005). Therefore, since the computed value was 0.846 it is greater than 0.5, hence the instrument is considered valid.

Reliability

Reliability of the questionnaire was ensured through pilot study and data collected from sample of respondents were analysed and computed using SPSS software. The results are presented in tabular format below.

Table 3: Reliability Statistics

Cronbach's Alpha	N of Items
.820	34

Source: Primary Data (2023)

For the instrument to be accepted as reliable, average index should be 0.5 or above (Amin, 2005). Hence, since the computed values above were greater than 0.5the instrument used in this study was considered reliable.

Data collection procedure

The researcher collected the data from students of Sokoto state Tertiary Institutions to measure their learning styles with the description questionnaire which was adopted from Felder and Solomon Index of Learning Styles Questionnaire (2006), given that it generates data with satisfactory internal consistency reliability and that evidence for its validity is strong, (Thomas, Litzinger, Sangha Lee, John, Wise et.al, 2007). 0.56 to 0.77 Felder &Spurlin, (2005). There is no need for its validation.

The researcher constructed a second questionnaire to collect data on educational technology pedagogy. The questionnaire received a validity score of 0.87, which indicates that it is deemed valid since it is greater than 0.5. Furthermore, the instrument is considered reliable.820.

Data Analysis

In order to comprehend the research problem, this study used a quantitative approach. All research questions required MANOVA and descriptive statistical methods (frequency and percentage).

Analysis of the Key Research Questions

This section focused on the analysis of the key research questions. Data based on each research question were collected using questionnaire which were analyzed using Multivariate Analysis of Variance.

Age Distribution of the Respondents

Table 4: Number of Respondents by Age

Age	Frequency	Percent
21-30	180	51.1
31-40	98	28.7
41-50	74	21.0
51 above	0	0
Total	352	100

Source: Field data, 2023

Results presented in table 4. reveals that 180(51.1%) of the students were in the range of 21-30 years. It was also observed that 98(28.7%) of the students were in the range of 31-40 years.

Furthermore, the result noted that 74(21.0%) of the students were in the range of 41-50 years. This gender distribution of the respondents may affect the way the students use computers in their learning process in order to meet their learning style.

Computer Literacy

Table 5: Computer Skills

Skills	Frequency	Percent
Proficient	60	17.0
Good	240	68.1
Satisfactory	45	13.6
Unskilled	7	1.9
Total	352	100

Source: Field data, 2023

Result presented in table 5 reveals that 60(17.0%) of the students were proficient while 240(68.1%) were good in basic computer skills. It was further noted that 45(13.6%) of the students were satisfactory while 7(1.9%) were unskilled in basic computer skills. Lack of basic computer skills will prevent the students from using Educational Technology platforms such Synchronous, Asynchronous and personalized learning in meeting their different learning styles.

Research Question 1: What is the impact of educational technology pedagogy in the Post-Covid 19 era between Active and Reflective learning styles for Sustainable learning among tertiary institutions in Sokoto state?

Table 6: I understand better after I:

Active and Reflective	Frequency	Percent
Try it out	192	54.5
Think it through	160	45.5
Total	352	100

Source: Field data, 2023

Table 6: highlights that 192(54.5%) of the students are Active learners reported that they understand better after they try out the task. However, 160(45.5%) of the students are Reflective learners reported that they understand better after they think through the task. Based on the levels of response from the table, it suggests that majority of the students are Active learners whom understand better after they perform the task. This enables the students to appreciate Educational Technology Pedagogy such as virtual learning, multimedia learning and Asynchronous learning. In support of this claim, (Sattar, 2020). reported transitioning to a largely online learning system, educational institutions are able to continue providing students with quality instruction and access to educational resources despite the barriers imposed by the pandemic. In similar view,

Table 7: Multivariate Test: Active-Reflective

Effect		Value	F	df	Sig.	Partial Eta Squared
Active-Reflective	Pillai's Trace	.671	2.134	3.00	.021	.03
	Wikis' Lambda	.652	2.133	3.00	.021	.03
	Hotelling's Trace	.782	2.125	3.00	.021	.03
	Roy's Larget Root	.346	2.321	3.00	.023	.03

Source: Field data, 2023

Table 7: This set of multivariate tests of significance indicating whether there are statistically significant differences among the groups on a linear combination of the independent variables. There are a number of statistics to choose from (Wilks' Lambda, Hotelling's Trace, Pillai's Trace). There was a statistically significant difference between active and reflective learning styles on the combined independent variables. Based on Wilks' Lambdaand its associated significance level (**Sig.**). If the significance level is *less* than .05, then you can conclude that there is a difference among the groups. The obtained Wilks' Lambda value is .652 with a significance value of .021. This is less than .05, therefore, there is a statistically significant difference between active and reflective learning stylesin use of online learning, offline and Multimedia learning: *F (3) = 2.133, Sig = .021 < p = .05; Wiki's Lambda = .652; partial eta squared = .03.*

Research Question 2:How is the impact of educational technology pedagogy in the post-Covid era between Verbal and Visual learning styles for Sustainable Education among tertiary institutions in Sokoto state?

Table 8: When I think about what I did yesterday, I am most likely to get:

Visual and Verbal	Frequency	Percent
Picture	188	53.4
Words	164	46.6
Total	352	100

Source: Field data, 2023

Result presented in table 7 reveals that 188(53.4%) of thestudents were Visual learners who think in pictures. Furthermore, 164(46.6%) Verbal learners, reported that they think in words. Based on these responses, it suggested that visual learners are likely to use online and multimedia tools in their learning experience. These learners are likely to read texts incorporated with graphics or images. Additionally, they are likely to make sketches when they are reading. In support of this assertion, Gardner (1993) opined that visual learner think in pictures while verbal learners think in words.

Table 9: I remember best:

Visual and verbal	Frequency	Percent
When I see	185	52.6
When I hear	167	47.4
Total	352	100

Source: Field data, 2023

Table 9's results show that 185 (52.6%) of the students said they remembered information better when they saw it, while 167 (47.4%) said they remembered information best when they heard it. This demonstrates that, due to its capacity to promote strong concept memory, the majority of students choose visual education. This result was consistent with Coleman's (2008) research, which claimed that people typically retain 10% of what they hear and 20% of what they see.

Table 10: Test of between-Subject Effects: Visual-Verbal

Source	Dependent variable	Df	F	Sig.	Partial Eta Squared
Visual-Verbal	Online learning	1	1.272	.003	.050
	Offline learning	1	1.457	.000	.222
	Multimedia L	1	4.347	.000	.315

Source: Field data, 2023

The statistical findings in Table 10 were further examined in regard to each of the dependent variables. Do Visual and Verbal Learners differ on all of the independent measures, or just some of them? Examining the mean scores revealed that visual learners are more likely than verbal learners to employ online learning, offline learning, and multimedia learning environments (M = 1.78, 1.76, and 1.86, respectively) than their counterparts.

Based on the findings of the study, the following conclusion were made:

Research Question 1: What is the Impact of Educational Technology Pedagogy in the post-Covid19 Era between Active and Reflective learning styles for Sustainable learning among tertiary institutions in Sokoto state?

- In this study, educational technology pedagogy in the post-Covid19 Era for Sustainable learning was found to be differently connected with the active and reflective dimensions of learning style. Active learners appreciate collaborative learning, which motivates them to participate in online forums, asynchronous learning, and customized learning. Synchronous learning is frequently used by reflective learners.
- Active learners frequently use simulations and games as well as other technologies that require hands-on expertise. In terms of how they use digital educational technology pedagogy, university students who are active learners differ from their peers who are reflective learners.
- Universities are able to continue providing high-quality instruction to active and reflective learners with a range of learning preferences, including synchronous, asynchronous, and hybrid learning, as well as access to educational resources, despite the pandemic's limitations by converting to a system that is primarily online.
- The results indicate that educational technology can be a useful tool for improving academic outcomes and helping to ensure that learning continues for both active and reflective learners who had different learning styles despite the pandemic's restrictions, in addition to providing advice on more efficient ways for teachers to manage online and hybrid classrooms.

Research Question 2: what is the level of Educational Technology Pedagogy impact in the Post-CovidEra between Verbal and Visual learning styles for Sustainable Education among tertiary institutions in Sokoto state?

- In the Post-Covid19 Era for Sustainable learning, university students who prefer studying with images are more likely to use all educational technology pedagogy, including synchronous (online learning), asynchronous (offline learning), and multimedia learning. In terms of how they use educational technology, most visual learners use it differently than verbal learners.
- The Post-Covid 19 Era usage of educational technology pedagogy ensures that students at universities continue to learn while also accommodating their preferences for various learning styles
- The application of educational technology digital learning environments and online course materials can help to increase student engagement, lessen administrative work, and meet the needs of each individual student. In the end, this offers a more viable and efficient means to continue learning in these trying circumstances.

Recommendations

Based on the findings of this study, the following recommendations were made.

- Those universitiesshould provide students with access to a variety of educational technology resources that will suit their preferred learning styles. These could be feasible through Tetfund support to the universities where Educational Technology Resource Centers are constructed to meet the demands of digitalization and Sustainable learning in the twenty-first century and beyond.

- In the Post-Covid19 Era, it appears essential for teachers to be conversant with the variety of learning styles when developing lesson plans. These will go a long way toward satisfying the students' needs, wants, and aspirations as well as mitigate challenges experienced during learning session.
- The use of educational technology pedagogy, such as virtual classrooms and online course materials, can enhance student involvement, lessen the workload on administrative staff, and meet the certain specific needs of each student. In the end, this gives people a more viable and efficient way to continue their learning in these trying circumstances.

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