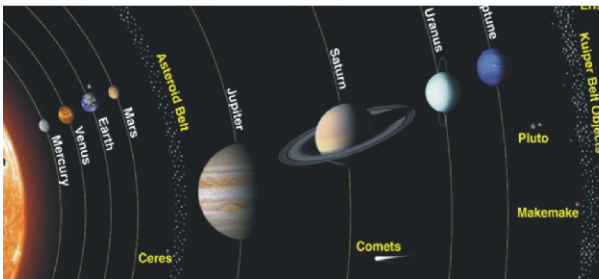


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EDITORIAL COMMENT

Knowledge they say is dynamic as it experiences phenomenal expansion by the hour. Education, in its totality of objectives, content, method and assessment, is also constantly undergoing multidimensional amplification. Against this backdrop, research is thought to be the bedrock of all knowledge and educational leaps.

It is upon this philosophy that we are pleased again to present the third edition of the ***Journal of Research in Science and Technology Education (JOREST)***, an official publication of the School of Secondary Education (Science), Federal College of Education (Technical), Asaba.

Contributors are drawn from various levels and fields of learning, but with a common passion for research and academic impact, it is our belief that this choice collection of research articles evoke a hunger for more research and more publications. This will ultimately lead to collaboration in our quest for advancement of the body of knowledge across several disciplines towards national development.

The editorial board wishes to acknowledge all contributors, editors and consulting editors alike. We equally appreciate College Management for opportunity to serve. Finally, We wish to assure our esteemed readers of our commitment improvements in contents/presentations in subsequent volumes.

Prof. Francis Arimatoro

Federal University of Technology, Minna

Editor -in- Chief



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Promoting Science and Technology Based Learning in Physics Education for Sustainable National Development

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Abstract

This study investigated the strategies for promoting Science and technology-based learning in Physics Education in Nigeria for sustainable national development. The research adopted descriptive survey design. The study was carried out in some selected tertiary institutions in Delta state. The population of the study comprised of all Physics students and Physics teachers in all the tertiary institutions in Delta state.. The sample of the study comprised of thirty (30) Physics teachers and thirty (30) Physics students selected from two (2) Universities, two (2) Polytechnics and two (2) Colleges of Educations using simple random sampling technique .The instrument used for data collection was a four point scale rating structured questionnaire. The data collected were analyzed using mean and standard deviation. The results from the study revealed that the government, the Physics teachers, the institutions and students are stakeholders for promoting science and technology based learning in Physics education in Nigeria. Some of strategies are: building and equipping of ICT centers, provision of quality laptops for Physics teachers. Acquisition of ICT skills by Physics teacher; provision of conducive learning environment, maintenance of ICT centers and use of ICT facilities by students in doing assignments. The paper recommends amongst others that government should be committed to building and equipping ICT centers and train Physics teachers on the use of ICT facilities, institutions should ensure conducive learning environment and students should endeavour to make use of ICT tools in their studies.

Keywords: *Physics, Science, Information and Communication Technology, Education, Sustainable Development*

Introduction

Physics is the study of the nature of matter and properties of matter and energy. Physics is the backbone of technology and plays a vital role in sustainable development of a nation. It finds its applications in communication, medicine, security, industry, transportation, agriculture, education and economy. A number of studies showed that Lecture, demonstration and discussion methods are commonly used by Physics teachers in teaching Physics both in secondary schools and tertiary institutions. In Nigeria today, the teaching of Physics using conventional methods cannot meet the needs of the society. For Physics to play its role as the backbone of



technology that will lead to sustainable development in Nigeria there is need to integrate the use of technology in day to day teaching of Physics.

The use Information and Communication Technology (ICT) in education has the potential to transform teaching. Laleye (2022) opined that technology has been used in all facets of life since its advent in which education is not left out. He further stated that ICT has been used to transfer knowledge from teacher to students, texts to students, students to students and that it makes learning to be mobile and learning is at learners' pace and the convenient time. That teacher can reach out to his students without face-to-face interaction and teaching can be in such a way that all students in the group will be carried along. Schoep (2005) opined that integrating ICT into teaching and learning is a complex process and that one that may encounter a number of difficulties. Up-to-date technology offers many methods of enhancing classroom teaching and learning. (Ghavifekr, Ahmad, Yao & Zhang, 2014; Lefebvre, Deaudelin & Loiselle, 2006).

Dawes (2001) stated that new technologies have the potential to upkeep education across the curriculum and deliver opportunities for efficient student-teacher communication in ways not possible before. Technology based learning is the integration of instructional technology into learning environment of schools. Bizi and Shitu (2014) defined ICT defined as a diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information. ICT allows the establishment of rich networks of interconnections and relations between individuals and provides fast and accurate feedback to learners (Abdullahi, 2014). Eleimeije and Tran (2019) asserted that ICT has been demonstrated to make Physics education more relevant, more linked to real life and more authentic and can increase the opportunities for own investigations by the students.

According to Chipunza (2013), wireless technologies such as laptop computers, mobile phones especially smart-phones, create a revolution in education that transform the traditional classroom-based learning into lifelong learning which have worked well with the blooming of the digital age. Kerry (2007) asserted that technologies as information source help to enrich the learning experience, motivate learners and meet the diversity in their backgrounds, and allow teachers to facilitate and monitor collaborative learning activities, to keep records, to track student progress as well as to provide timely feedback to the students. Ademiotan and Olotu (2021) opined that Computer-mediated communication technologies have evolved to the extent that they can be effectively utilized in this re-engineering process because they have the potential to support interactive pedagogies. He also opined that a shift is now possible from static content (text, illustrations, graphs, charts, photos, or maps) towards supporting knowledge production through interactive learning environments (with animation, video, or interactive illustrations) and thus,



facilitating flexible and distributed engaged learning that provide wider educational opportunities. Anderson (2010) asserted that technologies help to promote online discussion forums, web conferencing, allow learners to communicate, interact and share their ideas and interests with each other thereby improving the quality of education. Okoriocha and Eronini (2016) opined that ICT Facilities have the capacity not only to engage students in instructional activities to enhance their learning but also to help them solve complex problems in order to increase their cognitive skills.

There are numerous challenges facing science and technology based learning in Physics education in many developing world like Nigeria today. Ojih, Olodu and Okafor (2024) investigated challenges facing the utilization of ICT facilities in teaching and learning of Physics in tertiary institutions in south- south geopolitical zone of Nigeria. from their findings, some of the challenges they identified are: inadequate supply of ICT hardware facilities, slow internet connection to relevant websites, epileptic power supply within and outside the schools, inadequate funding for ICT facilities, poor attitude towards ICT facilities by the school authorities and management, high cost maintenance of ICT facilities, inadequate number of available and accessible ICT facilities., breakdown of computers, printers and other ICT facilities and inadequate technical support. Salehi and Salehi (2012); Agyei and Voogt (2011) also identified similar challenges facing the integration of ICT in Physics education.

Statement of the Problem

Physics that plays a significant role in technological and sustainable development of a nation. In Nigeria, a number of studies showed that Lecture, demonstration and discussion methods are commonly used by Physics teachers in Secondary schools to teach Physics. These methods did not only lead to mere knowledge acquisition through memorization which render students passive in class but also make students to depend solely on information from the teacher. Physics taught to students in this way cannot meet the need of the society and hence cannot lead to sustainable development. Therefore the teaching of Physics must move from conventional teaching approach to science and technology based learning which is activity based learning in which students are given considerable autonomy and guided in learning activities to observe experiment and solve problems. The integration of science and technology based learning in Physics education has the potential to transform teaching that will produce Physics graduates for sustainable national development.

Purpose of the Study

The main purpose of this study was to investigate strategies for promoting science and technology based learning in Physics education in Nigeria for sustainable development. Specifically the study sought to:



1. Find out the strategies from the government as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development.
2. Find out the strategies from the Physics teachers as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development.
3. Find out the strategies from the institution as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development.
4. Find out the strategies from Physics students as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development.

Research Questions

The following research questions guided the study.

1. What are the strategies from the government as stake holders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?
2. What are the strategies from the Physics teachers as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?
3. What the strategies from the institution as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?
4. What are strategies from Physics students as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?

Methodology

The research adopted descriptive survey design. The study was carried out in some selected tertiary institutions in Delta state. The population of the study comprised of all Physics students and Physics teachers in all the tertiary institutions in Delta state.. The sample of the study comprised of five (5) Physics teachers and five (5) Physics students each from two (2) Universities, two (2) Polytechnics and two (2) Colleges of Educations randomly selected using simple random sampling technique. The instrument used for data collection was a four point scale rating structured questionnaire. The scale rating of items in the questionnaire is Strongly Agree (4), Agree (3), Disagree (2) and strongly Disagree (1). The questionnaire consists of two sections, A and B. Section A contains the demographic data of the respondents while section B consist of four clusters. Cluster one contains eight (8) statement items that focus on roles of government in promoting science and technology based learning in Nigeria. Cluster two contains seven (7) statement items that focus on roles of Physics

teachers in promoting science and technology based learning in Nigeria. Cluster three contains five (5) statement items that focus on roles of institutions in promoting science and technology based learning in Nigeria while Cluster four contains six (6) statement items that focus on roles of Physics students in promoting science and technology based learning in Nigeria. The instrument was validated and pilot study of the instrument was carried out by administering the instrument to ten (5) Physics teachers and five (5) Physics students each in one university, one Polytechnic and one College of Education outside out the selected schools in Delta state. The result from the pilot study yielded a correlation coefficient of 0.76. The research questions were analyzed using mean and standard deviations. Decisions were taken using the mean value of the four point scale of 2.5.

Results

Research Question One

What are the strategies from the government as stake holders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?

Table I: Mean and Standard Deviation of Respondents to Research Question One

S/N	Statement Items	Mean	S.D	Decision
1.	Must take education funding a matter of priority	3.85	0.62	Agree
2.	Build and equip ICT Centers in schools	3.99	0.60	Agree
3.	Provide adequate laboratory equipment	3.70	0.66	Agree
4.	Provide quality laptops for teachers	3.65	0.75	Agree
5.	Organizing workshops and seminars for teachers	3.68	0.73	Agree
6.	Sponsor educative programs on radio and TV	3.41	0.81	Agree
7.	Provide incentives for teachers	3.71	0.61	Agree
8.	Approve grant for the running of the ICT centers and for buying modern laboratory equipment	3.61	0.78	Agree
Grand Mean		3.70	0.70	

Table 1 above shows the results of the answers of the respondents to strategies of government in promoting science and technology based Learning in Nigeria. The respondents agreed to all the item statements with grand mean of 3.70 and standard deviation of 0.70. In item 1, the respondents agreed with mean value of 3.85 that government must make education a matter of priority. In item2, respondents agreed with mean value of 3.99 that governments should build and equip ICT centers in schools. In item 3, the respondents agreed with mean value of 3.70 that government should provide adequate laboratory equipment. In item 4, the respondents agreed with mean value of 3.65 that government should provide quality laptops for teachers. In item 4, the respondents agreed with mean value of 3.65 that government should provide quality laptops for teachers. In item 5, the respondents agreed with mean value of 3.68 that government should organizing workshops and seminars for

teachers. In item 6, the respondents agreed with mean value of 3.41 that government should sponsor educative programs on radio and television. In item 7, the respondents agreed with mean value of 3.71 that government should provide incentive for teachers. In item 8, the respondents agreed with mean value of 3.61 that government should approve grant for the running of the ICT centers and for buying modern laboratory equipment

Research Question Two

What are the strategies from the Physics teachers as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?

S/N	Statement Items	Mean	S.D	Decision
1.	Create time for science and technology based learning	3.52	0.65	Agree
2.	Must be ready to acquire Laboratory and ICT skills	3.36	0.78	Agree
3.	Make effort to integrate ICT into teaching using available resources.	3.45	0.68	Agree
4.	Teach topics that are abstract in nature in classroom using computer or android/ smart phones by using video	3.63	0.60	Agree
5.	Use new innovative methods of teaching	3.42	0.73	Agree
6.	Give assignments to students using technological devices like phone	3.41	0.63	Agree
7.	Engage students with sufficient laboratory practical	3.36	0.74	Agree
Grand Mean		3.45	0.69	

Table 2 above shows the results of the answers of the respondents to strategies Physics teachers in promoting science and technology based Learning in Nigeria. The respondents agreed to all the item statements with grand mean of 3.45 and standard deviation of 0.69. In item 1, the respondents agreed with mean value of 3.52 that Physics teachers should create time for science and technology based learning. In item 2, the respondents agreed with mean value of 3.36 that Physics teachers must be ready to acquire laboratory and ICT skills. In item 3, the respondents agreed with mean value of 3.45 that Physics teachers must make effort to integrate ICT into teaching using available resources. In item 4, the respondents agreed with mean value of 3.63 that Physics teachers can teach topics that are abstract in nature in the classroom by using computer or android or smart phones or using video annihilation without the teachers. In item 5, the respondents agreed with mean value of 3.42 that Physics teachers should use new innovative methods of teaching.

In item 6, the respondents agreed with mean value of 3.41 that Physics teachers give assignments to students using technological devices like phones.. In item 7, the respondents agreed with mean value of 3.36 that Physics teachers should engage students with sufficient laboratory practical.

Research Question Three

What the strategies from the institution as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?

Table 3: Mean and Standard Deviation of Respondents to Research Question Three

S/N	Statement Items	Mean	S.D	Decision
1.	Ensure conducive learning environment	3.48	0.67	Agree
2.	Ensure adequate training of teachers and technical support staff	3.36	0.71	Agree
3.	Maintain of laboratory equipment	3.41	0.62	Agree
4.	Maintain ICT centers and ICT tools	2.93	0.81	Agree
5.	Ensure ICT Centers are available for use	3.36	0.68	Agree
Grand Mean		3.31	0.70	

Table 3 above shows the results of the answers of the respondents to strategies from institutions in promoting science and technology based Learning in Nigeria. The respondents agreed to all the item statements with grand mean of 3.31 and standard deviation of 0.70. In item 1, the respondents agreed with mean value of 3.48 that institutions should ensure conducive learning environment. In item 2, the respondents agreed with mean value of 3.36 that institutions should ensure adequate training of teachers and technical support staff. In item 3, the respondents agreed with mean value of 3.41 that institutions should maintain laboratory equipment. In item 4, the respondents agreed with mean value of 2.93 that institutions should maintain laboratory equipment. In item 5, the respondents agreed with mean value of 3.36 that institutions should ensure that ICT Centers are available for use

Research Question Four

What are strategies from Physics students as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development?

Table 4: Mean and Standard Deviation of Respondents to Research Question four

S/N	Statement Items	Mean	S.D	Decision
1.	Do assignments using technology devises suchas laptops and smart phones	3.42	0.73	Agree
2.	Use internet facilities to get lecture notes and research work such as project work	3.38	0.67	Agree
3.	Participate and contribute to the radio and TV sponsored educative programmes	3.12	0.81	Agree
4.	Make positive use of ICT gadgets both at home and in school	3.22	0.79	Agree
5.	Adjust to instruction, provide support and feedback using technology devices to create flexible, adaptable assignments and group work	3.10	0.79	Agree
6.	Must engage in Physics laboratory practical	3.67	0.62	Agree
Grand Mean		3.32	0.74	



Table 4 above shows the results of the answers of the respondents to strategies from Physics students in promoting science and technology based Learning in Nigeria. The respondents agreed to all the item statements with grand mean of 3.32 and standard deviation of 0.74. In item 1, the respondents agreed with mean value of 3.42 that Physics students should do assignments using technology devices such as laptops and smart phones. In item 2, the respondents agreed with mean value of 3.38 that Physics students should use internet facilities to get lecture notes and research work such as project work. In item 3, the respondents agreed with mean value of 3.12 that Physics students should participate and contribute to the radio and television sponsored educative programmes. In item 4, the respondents agreed with mean value of 3.22 that Physics students should make positive use of ICT gadgets both at home and in school. In item 5, the respondents agreed with mean value of 3.10 that Physics students should adjust to instruction, providing support and feedback by using technology devices to create flexible, adaptable assignments and group work. In item 6, the respondents agreed with mean value of 3.67 that Physics students must engage in Physics laboratory practical

Discussion of Results

The results from this findings revealed the strategies from the government as stakeholders in promoting science and technology based learning in Physics education in Nigeria for sustainable development. The strategies from the government are: make education a matter of priority, build and equip ICT centers, provide adequate laboratory equipment, provide quality laptops for Physics teachers, organize seminars and workshops for teachers, sponsor educative programmes in radio and television, provide incentives for Physics teachers, approve grants for running of ICT centers and buying modern physics laboratory equipment. The strategies from Physics teachers as stakeholders in promoting science and technology based learning in the classroom. for sustainable development as revealed from this findings include:: Physics teachers are to create time for science and technology based learning, must be ready to acquire laboratory and ICT skills, make effort to integrate ICT into teaching using available resources, ensuring that topics that are abstract in nature are taught in the classroom using computer, android or smart phones through video animation without being present physically in classroom, should use new innovative methods of teaching, give assignments to students using technological devices like phones and engaging students with sufficient laboratory practical. This will enhance students' creativity, thinking and manipulating skills. This finding corroborates with the findings of Ghavifekr, Ahmad, Yao and Zhang (2014); Lefebvre, Deaudelin and Loiselle (2006) who opined that up-to-date technology offer many methods of enhancing classroom teaching and learning. This finding is also in line with the findings of Dawes (2001) who asserted that new technologies have the potential to upkeep education across the curriculum and deliver opportunities for efficient student-teacher communication in ways not possible before.

Furthermore, the strategies from the institution as stakeholders in promoting science and technology based learning in Nigeria for sustainable development as revealed from the findings are: ensuring conducive learning environment, ensuring adequate training of teachers and technical support staff, maintenance of laboratory equipment, maintenance of ICT centers and ICT facilities and ensuring ICT Centers are available for use. The result further reveals the strategies from the students as stakeholders in promoting science and technology based learning in Physics Education in Nigeria for sustainable development as follows:: doing assignments using technology devices such as laptops and smart phones, use internet facilities to get lecture notes and research work such as project work, participating and contributing to radio and television sponsored educative programmes, making positive use of ICT gadgets both at home and in school, adjusting to instruction by providing support and feedback using technology devices and engaging in practical work. These strategies if adopted by the students will enable students to have confidence in their ability to achieve their goals thus leading to productivity. This finding is in line with the finding of Okoriocha and Eronini (2016) who opined that ICT Facilities have the capacity not only to engage students in instructional activities to enhance their learning but also to help them solve complex problems in order to increase their cognitive skills.

Conclusion

Physics as a science subject plays a vital role in sustainable development of a nation. The teachings of Physics need to move from conventional methods to science and technology based learning by integrating the use of ICT in day to day teachings of Physics in Nigeria for sustainable development. Though there are challenges facing the integration of ICT in Physics education but technology based learning is the way to go if we must attain sustainable development as a nation. This study has revealed the various strategies from the stakeholders: the government, the Physics teachers, the institutions and the students in promoting science and technology based learning in Nigeria for sustainable development. The government should be committed to funding Physics education by building ICT centers in schools, provide ICT facilities and equip Physics laboratory with modern equipment. Physics teachers are to technically and strategically make use of ICT facilities in their day to day teaching, Institutions are to ensure conducive environment while the students are to make use of ICT facilities available to them for their studies and assignments.

Recommendation

The following recommendations was made.

1. The government should see education as a matter of priority and be committed to providing funds to build and equip ICT centers and Physics laboratory.



2. The government should be committed to the training of Physics teachers in the use of new technology by organizing seminars and workshops.
3. Physics teachers should endeavour to acquire ICT skills and also integration in Physics lessons.
4. Students should endeavour to make use of ICT tools in their daily studies

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Enhancing Pre-Service Chemistry Teachers' Service Delivery: A Panacea to Promoting Science and Technology Based Chemistry Education for Sustainable Development

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Abstract

Secondary school students still have misconceptions in electrochemistry. There is need to expose and determine pre-service chemistry teachers' achievement using a conceptual change strategy such as Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) with a view to enhancing their service delivery. Two research questions and two hypotheses that were tested at 0.05 level of significance guided the study. Seventy two (72) pre-service chemistry teachers constituted the population of the study. The sample for the study was made up of fifty eight (58) pre-service chemistry teachers drawn from the only Federal College of Education and one State College of Education in Delta State using simple random sampling (balloting technique). The schools were assigned to PEDDA instructional strategy and the Lecture method of instruction using toss of coin. Electrochemistry Achievement Test (EAT) developed by the researchers which was found to be valid and reliable was used for data collection. The research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses. The findings showed that there was a statistical significant difference in the mean achievement scores of pre-service chemistry teachers' taught electrochemistry with PEDDA instructional strategy and those taught using Lecture method of instruction in favour of the experimental group amongst others. Based on the findings it was recommended amongst others that the National Commission for Colleges of Education (NCCE) should incorporate PEDDA instructional strategy in the National Certificate of Education (NCE) minimum standards as part of the strategies for teaching especially the science courses for sustainable development.

Keywords: Chemistry, Achievement, Electrochemistry, Prior conception, Exploration,

Introduction

Science and technology education are critical to sustainable national development. Chemistry is one of such science subjects. Ababio (2015) sees chemistry as a branch of science that deals with the composition, properties and uses of matter. It probes into the principles governing the changes that matter undergoes. Chemistry



education as an aspect of science education aims at developing individuals who would be able to apply skills and knowledge gained in solving everyday problems in the society for sustainable development. Credit level passes in chemistry at the ordinary level certificate examination is a prerequisite for subsequent specialist studies in pure chemistry, chemistry education, biochemistry, medicine, amongst others. All these fields of human endeavour needed for sustainable development require chemistry knowledge. This ensures meeting the needs of the current generation without compromising the needs of the future ones, so that society can exist in continuous harmony. This has necessitated the need to equip current and future citizens in general and chemistry students in particular with the right conceptual understanding of chemistry concepts for sustainable development. Such important concepts in chemistry include galvanic cells, electrolysis, electrode reactions, electrolytic reactions and Faradays' laws amongst others. All these can be grouped under the broad topic, electrochemistry which is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reaction. If these topics are well understood, it has a crucial role to play in helping to find answers to various human and socio economic problems such as rusting amongst others.

At the National Certificate in Education (NCE) level, chemistry education is designed to produce competent chemistry teachers with the capacity to further encourage the spirit of inquiry and creativity in the learners and to apply the skills and knowledge to solve day-to-day problems (NCCE, 2020). However, these objectives are yet to be achieved in our schools and colleges given the poor academic achievement of students in chemistry recorded in recent times. The identified importance of chemistry raises the concern about pre-service chemistry teachers' ability to prepare students for the 21st century knowledge society. The recent research of Okotcha, Oghenejode and Eze (2021) shows that chemistry students still have some misconceptions in electrochemistry. Could this persistence be as a result of the teachers' methodology? It is pertinent to note however that no education system can rise above the level of its teachers (FRN, 2004). By implication, the quality of teacher education in chemistry determines to a great extent the quality of chemistry learning outcomes which has great role to play in science and technological development. The persistent difficulties students may be having in chemistry concepts especially electrochemistry could be because the pre-service teachers' preparation programmes in Colleges of Education are still based predominantly on traditional practices such as lecture method (Agoro, 2013) which does not give them the opportunity to deal with some of the misconceptions they may be having in the concept. Hence, after graduation, they find it difficult to teach the students effectively leading to low achievement. From the foregoing, it is necessary for the pre-service chemistry teachers' who are being trained as the facilitator of knowledge to be well equipped with good methodologies and having the right conceptual understanding for a good



service delivery. Hence, there is an urgent need to expose and equip the pre-service chemistry teachers to inquiry based strategies which can be used to remove these misconceptions leading to greater achievement and for sustainability.

The pre-service chemistry teachers have been taught using the conventional lecture method, there is need to expose them to other inquiry based methods of teaching that are student centered strategies that could remove misconceptions students tend to have in electrochemistry thus equipping them for the service ahead. Such strategies include Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) instructional model. Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) is a five step conceptual change instructional model developed by Nworgu (1996) based on adaptations from Stofflet and Stoddarts (1994). The acronym PEDDA was derived from the initial letters of the processes involved. The processes are: determination of Prior knowledge, Exploration of the phenomenon, Discussion of the experiment, Development of dissatisfaction with prior conception.

The first step involves the diagnosis of students' prior knowledge. Some of these conceptions are illogical or intuitive. Prior to instruction, students are given a written test (pre-test), this enables one to identify the students' prior concepts. Step 2 involves exploring the phenomenon in question. Students are provided with materials and activities with focusing questions that will allow the students to observe the phenomenon and reflect on and communicate their ideas about scientific phenomenon using experiences that illustrate the particular concept (Stofflet & Stoddart, 1994). These activities are such that they tend to counter the prior conceptions of the students. In step 3 students are provided with scientific information and experiments/activities are created through which the students are led to arrive at scientifically accepted explanation of concepts/principles. In providing the information, the teacher uses a variety of techniques such as explaining and questioning in directing students thinking. In step 4, new conception or scientifically accepted concept or principles developed in step 3 are compared to the original ideas or pre-conceptions stated in step 1. The students are asked to examine each of their original conceptions and state whether they still believe in them and rationale for their answer in terms of the experiments and discussions. If there are still illogical or alternative conceptions, the teacher returns to step 2, otherwise the instruction progresses to the final step which is application. This stage offers the students the opportunities to develop the fruitfulness by applying the new concepts/principles to real world situations. The students are asked to provide examples of the concept/principles occurring in real world situation.

The PEDDA model involves exploration and provides the learner with the opportunity to test a range of his preconceptions/ misconceptions against actual experience from his own activities and apply the new experiences in order to



experience its usefulness (Okotcha, 2018). Ukwueze (2012) investigated the effect of PEDDA constructivist instructional model on secondary school students' achievement in Biology. The study adopted quasi-experimental design. The study was restricted to secondary school one (SS1) Biology students in Nsukka Education zone of Enugu State. The sample of the study comprised of two hundred and sixty-four (264) biology students. The study revealed that the experimental group that was taught with PEDDA performed better than the control group that was taught using the traditional method. In the same vein, Okotcha (2018) carried out a study on the effect of a constructivist-based instructional model PEDDA on students' conceptual change in chemistry. The study was carried out in the three senatorial districts of Delta State with a population of 2,430. The sample of the study consisted of 168 chemistry students. Mean and standard deviation were used in answering the research questions while analysis of covariance (ANCOVA) was used in testing the hypotheses. The result revealed that PEDDA facilitated students' conceptual change more than the conventional method used in teaching the control group. The study however noted that some students still held on to some misconceptions in electrochemistry.

From the fore going, it is necessary that these step- by- step sequences of PEDDA instructional model be imbibed by pre-service chemistry teachers during training at the colleges in order to become competent teachers with the capacity to further encourage the spirit of inquiry removing all forms of misconceptions leading to greater achievement among the learners at the secondary school and basic education levels, such that they can apply the knowledge for science and technological development. Exploring a phenomenon before explaining them is critical for conceptual change learning which leads to greater achievement. Hence, the researcher deemed it necessary to expose the pre-service chemistry teachers to Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) instructional model in other to improve their service delivery in science and technology for a sustainable development.

Achievement connotes academic performance in school subject as symbolized by a score or mark. Achievement can be described as something which has been accomplished successfully, especially by means of exertion, skill practice or perseverance. The author sees achievement as a test for the measurement and comparison of skills in various fields of academic study. Achievement can be seen as a systematic and purposeful quantification of learning outcomes. Achievement involves the determination of the degree of attainment of individuals in tasks, courses or programs of which the individuals were sufficiently exposed. Students' achievement connotes academic performance in school subject as symbolized by a score or mark on achievement test. According to Danladi (2017), students' academic achievement is quantified by a measure of the students' academic standing in relation



to those of other students of his age. One of the reasons for the low standard could be associated with the quality of teachers trained in the colleges of education (Adeyemi & Adeyemi, 2014). A strong relationship exists between high-quality instruction, teacher professional development and students' achievement (Araoye, 2013). Research (Eze, Obielumani & Okotcha, 2020; Danladi, 2017) confirmed that high-quality instructional model leads to greater achievement by the students. Hence this study is imperative.

Gender refers to the social or cultural construct characteristics, behaviours and role which society ascribes to males and females. The issues of gender in science have continued to receive attention by researchers. Gender poses instructional challenges to teachers. This has been a crucial matter to the educationists. Gender, according to Onah (2011), refers to the content of masculinity and femininity found in an individual. It highlights the differences between women's and men's interest even within the same household (by implication classroom) and how these interact and are expressed. It varies from time to time and from place to place. The issues of parity and disparity in the achievement of male and female science students have formed an important focus of research in recent years. This is in recognition of influence of gender and the position of the learner in any learning process. Hence, there is need to investigate the effect of PEDDA instructional model on achievement of both male and female pre-service chemistry teachers.

Statement of the Problem

Chemistry education as an aspect of science education aims at developing individuals who would be able to apply skills and knowledge gained in solving everyday problem in the society for sustainable development. This laudable objective will only be a mirage until students are taught in such a way as to deal with some of the misconceptions they still hold in chemistry especially electrochemistry. This is a function of the science teacher. Prospective science educators at the Colleges of Education need to be exposed to inquiry teaching strategies that could remove all forms of misconceptions students may have in a particular concept against the traditional lecture method of instruction which is predominantly used. This will lead to greater achievement in the subject leading to development in science and technology. The ability of chemistry teachers in particular to select and utilize appropriate instructional strategies in their lesson delivery is a function of the pre-service training they received from the teacher producing institutions and departments. Hence, there is need to expose the pre-service chemistry teachers to PEDDA instructional model that will help to remove all forms of misconceptions students may be having in the concept thus preparing them for the task ahead. This underscores the need for this study. Hence, the problem of the study posed as a question is: what is the effect of PEDDA instructional model on achievement of pre-service chemistry teachers?



Purpose of the Study

The general purpose of the study was to find out the effect of PEDDA instructional model on achievement of pre-service chemistry teachers in Colleges of Education in Delta State. Specifically, the study determined the:

1. Relative effectiveness of PEDDA instructional model on pre-service teachers' achievement in chemistry.
2. Influence of gender on pre-service teachers' achievement in chemistry.

Scope of the Study

The study was restricted to the determination of the effect of PEDDA instructional model on achievement of NCE 11 pre-service chemistry teachers in Colleges of Education in Delta State.

Research Questions

The study was guided by the following research questions

1. What is the effect of PEDDA instructional model on pre-service teachers' achievement in chemistry?
2. What is the influence of gender on pre-service teachers' on pre-service teachers' achievement in chemistry?

Hypotheses

The following hypotheses that were tested at 0.05 level of significance guided the study

H₀₁: There is no significant difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA instructional model and those taught using lecture method of instruction

H₀₂: There is no significant difference in the mean achievement scores of male and female pre-service teachers' when exposed to PEDDA instructional model.

Methodology

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because intact classes were used to ensure that regular class periods are not altered. The study was carried out in Delta State. The choice of the state was based on the observed misconceptions secondary school students still hold in electrochemistry. The population of this study consisted of all the 200 level chemistry students in the only Federal College of Education and the two State Colleges of Education in Delta State numbering seventy-two (72) students (62 girls and 10 boys). The sample of the study consisted of fifty-eight (58) pre-service chemistry teachers in two Colleges of Education - the only Federal College of Education and one State College of Education which was selected using simple

random sampling (balloting technique). The two Colleges of Education were randomly assigned to PEDDA instructional strategy and the lecture method of instruction using toss of coin. The instruments for this study are Electrochemistry Achievement Test (EAT).

The Electrochemistry Achievement Test (EAT) was used to test achievement of students in chemistry. EAT was developed by the researchers and it is a multiple-choice test consisting of twenty-five (25) items got from CHM 216. The Electrochemistry Achievement test (EAT) was constructed by the researchers and validated by experts in science education. The instrument was trial tested in two colleges of education of another state to determine the reliability. The scores obtained were tested using Pearson coefficient of correlation and was found to be reliable $r = 0.87$. Before the experiment, researchers with the help of the research assistants administered the pre-test to the students in the two groups. After this, the two treatment groups were exposed to the treatment which lasted for five weeks, afterwards the post-test was administered. The research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question One What is the effect of PEDDA instructional model and Lecture method of instruction on pre-service teachers' achievement in chemistry?

Table 1: Mean and Standard deviation of pretest and posttest of the effect of PEDDA and Lecture method of instruction on pre-service teachers' achievement in chemistry.

SN	Instructional Mode	N	Pretest		Posttest		Mean Gain
			\bar{X}	SD	\bar{X}	SD	
1.	PEDDA	26	23.35	4.45	40.62	4.23	17.27
2.	Lecture Method	32	20.34	4.10	28.62	3.46	8.28

Result on Table 1 shows that for each of the groups, the post-test mean scores were greater than the pretest mean scores with the group taught electrochemistry using the PEDDA-ANIMATED instructional strategy having a higher mean gain (17.27 > 8.28). This is an indication that the PEDDA instructional model improved pre-service teacher's achievement in chemistry than the lecture method of instruction.

H₀₁: There is no significant difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA instructional strategy and those taught using Lecture method of instruction.

Table 2: Analysis of Covariance (ANCOVA) of the difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA instructional strategy and those taught using Lecture method of instruction.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Remark
Corrected Model	2129.685a	4	532.421	37.509	0.00	0.739	
Intercept	2815.629	1	2815.629	198.359	0.00	0.789	
Pretest Ach	19.603	1	19.603	1.381	0.24	0.025	
Group	1263.664	1	1263.664	89.024	0.00	0.627	S
Gender	12.301	1	12.301	.867	0.35	0.016	NS
Group *Gender	46.868	1	46.868	3.302	0.07	0.059	NS
Error	752.315	53	14.195				
Total	69930.000	58					
Corrected Total	2882.000	57					

Note: S = Significant, NS = Not significant, $\alpha = 0.05$

Table 2 shows that the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA and those taught using lecture method was statistically significant ($p = 0.63$). Hence, the null hypothesis was rejected. Inference drawn is that there was a significant difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA instructional model and those taught using lecture method in favour of the group taught using PEDDA.

Research Question Two

What is the influence of gender on pre-service teachers' achievement in chemistry?

Table 3: Mean and Standard deviation of the influence of gender on pre-service teachers' achievement in chemistry

SN	Gender	N	Pretest		Posttest		Mean Gain
			\bar{X}	SD	\bar{X}	SD	
1	Male	8	24.33	2.16	48.49	1.84	24.16
2	Female	50	35.39	6.70	61.29	7.27	25.90

Result on Table 3 shows that for the male and female students, the post-test mean achievement scores were greater than the pretest mean achievement scores with the female students taught electrochemistry having a higher mean gain ($25.90 > 24.16$). This is an indication that the female students performed slightly higher than the male students.

H₀₂: There is no significant influence of gender on pre-service teachers' achievement in chemistry.

Result from Table 2 shows that there was no significant gender influence on Pre-service teachers' achievement in chemistry

Discussion of Results

Effects of PEDDA instructional model on pre-service teachers' achievement in chemistry

The findings of this study showed that pre-service teachers taught using PEDDA model scored higher than those taught using lecture method ($17.27 > 8.28$) as shown in Table 1 and difference was statistically significant as revealed in Table 2. This means that the use of PEDDA model improved pre-service teachers' achievement. This is due to the fact that PEDDA model offered students unique opportunities to be actively engaged in meaningful learning testing their preconceptions with real life experiences. The pre-service teachers diligently carried out the activities collaboratively interacting with themselves and resources with the teacher facilitating the construction of cognitive imprints guided by students' testing ideas. This result supports the findings of Ukwueze (2012) and Okotcha (2018) who noted that PEDDA instructional model facilitated students' achievement as well as conceptual change. This result is also in agreement with the findings of Danladi (2017). The study revealed that students taught with model-based inquiry instructional technique had greater achievement than students' taught with the conventional inquiry. These results further support the assertions of Dewey, Piaget and Vygotsky who maintained that knowledge is constructed by the learners and embodied in human experience. As prospective teachers, the experience obtained in the strategy will hopefully impact positively on their instructional delivery capability. The tempo will in due course improve teacher preparation for greater teacher effectiveness and may eventually improve their students' achievement at secondary schools which will lead to greater science and technological development in the society at large.

Influence of gender on pre-service teachers' achievement in chemistry when taught using PEDDA instructional model

The findings of the study as shown in Table 3 revealed that the female pre-service teachers achieved more than their male counterparts ($25.90 > 24.16$). However, the difference was found not to be statistically significant as revealed in Table 2. This means gender is not a significant factor in determining students' achievement in chemistry. This result disagrees with the findings of Danladi (2017) who noted that males performed significantly more than their female counterparts. However, this result is in line with the findings of Okotcha (2018) who noted that there was no



significant difference in the achievement of both males and females. Thus, both male and female pre-service teachers benefited significantly from the strategy and this gave them equal opportunities which is in agreement to the sustainable development goals. Hence, the male and female pre-service chemistry teachers are hopefully equipped for service delivery.

Conclusion

From the foregoing discussions based on the findings of the study, PEDDA instructional model improved Pre-service chemistry teachers achievement. Furthermore, there was no significant difference in the mean achievement of male and female pre-service chemistry teachers when taught with PEDDA instructional model. This means that gender did not interact with the instructional strategies to affect pre-service teachers' achievement. Hence, achievement of the concepts under study was due to the specific treatment that was given. Thus the PEDDA model is gender friendly.

Recommendations

Based on the findings reached in this study, the following recommendations were made:

1. The National Commission for Colleges of Education (NCCE) should incorporate PEDDA instructional model in the National Certificate of Education (N.C.E) minimum standard as part of the strategies for teaching especially the science courses.
2. College of Education Teacher educators (lecturers) should use PEDDA model in teaching pre-service teachers. This will assist the prospective teachers to acquire the required professional knowledge, attitudes and skills and even remove any misconception they may be having. This would enable them to become competent chemistry teachers with the capacity to further encourage the spirit of inquiry in their students leading to application of the knowledge acquired to solve day-to-day problems in the dynamic world.

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The Implications of Information and Communication Technology in Science and Technology Based Learning in Education Sector in Promoting National Development

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Abstract

This paper focuses on the implications of Information and Communication Technology (ICT) in Science and Technology Based Learning in Education Sector in Promoting National Development. Three research questions and three hypotheses guided the study. The study was a descriptive survey design. A six point likert type of questionnaire was developed, validated and administered to the respondents through simple random sampling technique. The responses gathered were coded and analyzed using independent t-test statistics for data analysis. Three null hypotheses were formulated and tested at critical t-test value of 1.96 at 0.05 level of significance. Based on the findings that resulted from this study, it was concluded that the availabilities of ICT, the use of ICT in education sector, and the impact of ICT on the influence of science and technology based learning, will improve and enhance science and technology based learning in education. It was also recommended that Government should equip the nation's educational sector and agencies with adequate ICT tools and facilities, train and retrains the stakeholders in educational sector and agencies on the use of ICT tools and its facilities in order to enhance sustainable national development.

Keywords: *ICT, Learning, Science, Technology, Education Sector, National Development*

Introduction

Information and Communication Technologies (ICT) is defined as a diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the Internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players, and storage devices) and telephony (fixed or mobile, satellite, visio /video-conferencing) (United Nations Educational, Scientific and Cultural Organization Institute for Statistics (UIS), 2009). ICT can also be defined as a set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information. These technologies include computers, the internet, and broadcasting technologies (radio and television), and telephony (Blurton, 2011). In the developed world, skill-based education has long been adopted and co-opted into their curriculum as a matter of policy (Leicht, Heiss & Byun, 2018).



Computer education in Nigeria in particular started with literacy programs organized either by government or private individuals or organizations, aimed at acquiring and promoting the acquisition of basic skills in Microsoft word and Corel draw such as typing, editing and printing of memos, letters as well as design of invitation and wedding cards among other related tasks. Those who acquired such skills became heroes in their towns. Some became self reliant by establishing their private training centers. Some left their towns and villages to cities where they secured jobs with federal, state or private organizations (Jegede & Owolabi, 2003). Initially, with the implementation of computer education in Nigerian schools, multimedia literatures were widely used during the teaching-learning process since computers were not commonly available. The target was on literacy. Later, the use of projecting device by teachers was used to demonstrate to the learner, what was supposed to be a practical experience by the learner. The target was to develop enthusiasm for practical skill in computer among students. A decade ago, computer laboratories were established in most schools. The target was for students to develop practical skills. However, Computer education for sustainable youth empowerment goes beyond acquiring just basic literacy skills (Krauss, Collura, Zeldin, Ortega, Abdullah, & Suleiman, 2014).

One of the problems that are facing developing countries today is sustainable development. Information and Communication Technologies (ICTs), which include radio and television, as well as newer digital technologies such as computers and the internet have been touted as potentially powerfully enabling tools for educational change and sustainable development. When used appropriately, different ICTs are said to help expand access to sustainable development, strengthen the relevance of ICT in education; organization (both private and public sectors) and will lead to the success of achieving goals and objectives for self-reliance. Hence, this paper therefore examines the implications of ICT in science and technology based learning in education sector in promoting national development.

Sustainable Development

Sustainable development can be broadly defined as the ability of the economy to support the needs of the people of a country over a time, taking into consideration the economic, social and ecological constraints of the country. ICT for sustainable development also represents a catalytic process for social change that seeks to foster through education training and public awareness-the values, behaviours and lifestyles required for sustainable future. It is about learning needed to maintain and improve our quality of life of generations to come. It is about individuals, communities, groups, business and government to live and act sustainably; as well as giving them an understanding of the environmental factor, good moral behaviours and economic issues involved (Ayodele, 2007). According to Okonta, Ajani, Owolabi, and Onwubuya & Onochie. (2013).



Information and Communication Technology (ICT) is seen as the science and skills of all aspects of computing, data storage, and communication. It is a new rapidly growing area that is radically changing the world by making possible new ways of doing business, making entertainment, creating art and teaching and learning. The current emphasis on the use of technology within businesses is not a mirage. Indeed, all indicators point to the increased use of technology and to organizations continued awareness of the importance of technology, both as a tool for productivity and as a vehicle for achieving competitive advantage and organizational change. People in organizations use information systems to process sales transactions, manage loan applications, or help financial analysts decide where, when, and how to market their products and related services, and production managers use them to help decide when and how to manufacture products (Joe & Christopher, 2010). They further propounded that data and knowledge are probably among the most important assets an organization has, as data and knowledge are essential for both executing business processes and gaining business intelligence. Databases, which are collections of related data organized in a way that facilitates data searches, are vital to an organizations success. Information once taken for granted or never collected at all is now used to make organizations more productive and competitive. Stock prices in the market, potential customers who meet a company's criteria for its products target audiences and the credit rating of wholesalers and customers are all types of information that organizations collect and analyze.

Objectives of the Study

The main objective of the study is to investigate the implications of information and communication technology in science and technology based learning in education sector in promoting national development. The specific objectives of this study include the following:

1. To find out whether the use of ICT improves science and technology based learning in education.
2. To ascertain whether ICT have any impact in promoting National Development.
3. To ascertain if there is influence of ICT on science and technology based learning

Research Questions

The following research questions guided the study.

1. Does the availability of ICT improves science and technology based learning in education?
2. What impact does the use of ICT have in education sector in promoting national development?
3. To what extent has the presence of ICT influence science and technology based learning?



Research Hypothesis

HO₁: There is no significant difference on the availability of ICT to improve science and technology based learning in education.

HO₂: There is no significant impact on the use of ICT in education sector in promoting national development.

HO₃: There is no significant influence of ICT on science and technology based learning.

Methodology

The research design adopted for this study was the survey descriptive study. The study area was Delta State of Nigeria. The study population comprises of all the tertiary institutions within the State. The sample consisted of 180 respondents (male and female) randomly selected through the simple random sampling from the higher institutions. The data analysis and results were presented with special reference to the research questions and hypothesis in the study. Each hypothesis was tested using the responses from respondents to the questionnaire which relates to and explain the various null hypotheses and the t-test statistical analysis.

Results

Hypothesis One

HO₁: There is no significant difference on the availability of ICT improves science and technology based learning in education.

Table 1 Summary Table of calculated t-test analysis for hypothesis one.

Availability of ICT	N	Mean	SD	Df	t-Calculated	t-Critical	Decision
Available	104	10.12	4.35	178	5.01	1.96	Significance
Not available	76	5.21	1.56				No Significance

$P > 0.05$, $df = 178$, $t\text{-critical} = 1.96$, $t\text{-calculated} = 5.01$

From table 1 above, it was observed that the t-calculated value of 5.01 is greater than the t-critical value of 1.96, at 0.05 level of significance. This implies that the null hypothesis one stated above is rejected as postulated and the alternative hypothesis is accepted. Therefore, the conclusion reached was that there is a significance difference on the availability of ICT in improving science and technology based learning in education.

Hypothesis Two

HO₂: There is no significant impact on the use of information and communication technology in education sector in promoting national development.

Table 2: Summary Table of calculated t-test analysis for hypothesis 2.

Use of ICT	N	Mean	SD	Df	t-Calculated	t-Critical	Decision
Adequately used	25	8.52	4.79	178	4.13	1.96	Significance
Not Adequately used	55	3.31	1.01				No Significance

$P > 0.05, df = 178, t\text{-critical} = 1.96, t\text{-calculated} = 4.13$

From table 2 above, it was observed that the t-calculated value of 4.13 is greater than the t-critical value of 1.96 at 0.05 level of significance. This means that the null hypothesis two stated above is rejected as postulated and the alternative hypothesis is accepted. Therefore, the conclusion reached was that there is a significance difference on the use of information and communication technology in education sector in promoting national development.

Hypothesis Three

HO3 There is no significant influence of ICT on science and technology based learning

Table 3: Summary Table of calculated t-test analysis for hypothesis Three

Use of ICT	N	Mean	SD	Df	t-Calculated	t-Critical	Decision
Adequately Used	106	6.20	4.64	178	4.02	1.96	Significance
Not Adequately Used	74	2.53	1.22				No Significance

$p > 0.05, df = 178, t\text{-critical} = 1.96, t\text{-calculated} = 4.02$

From table 3 above, it was observed that the t-calculated value of 4.02 is greater than the t-critical value of 1.96, at 0.05 level of significance. This means that the null hypothesis three stated above is rejected as postulated and the alternative hypothesis is accepted. Therefore, the conclusion reached was that there is a significant influence of ICT on science and technology based learning.

Discussion of Results

From table one above, in testing hypothesis 1; it was observed that there is a significant difference on the availability of ICT in improving science and technology based learning in education. This implies that ICT has impacted positively to the improvement of science and technology based learning in education. This is in agreement with Adamu, Mohammed, Saudu and Abbas (2010), which stated that the strategic use of Information and Communication Technology (ICT) in acquiring knowledge and skills has become an essential ingredient in education and training and these ingredients in the educational process have magical effects. Similarly, in testing hypothesis two, as revealed in table two above, it was equally observed that there is a significance difference on the use of ICT in education sector in enhancing national development. This also, is in agreement with Aduwa-Ogiebean and Iyamu (2015), which was of the opinion that the importance and significance of ICT to both



teaching and learning are quite evident in educational sector. Finally, the result of testing hypothesis three as showed in table three above, also reveals that there is a significant influence of ICT on science and technology based learning. This is in line with Ojo & Adu (2018), which opined that ICT in education include but are not limited to electronic machines and devices used to help the teacher achieve the set goals and objectives in teaching and learning within the shortest time.

Conclusion

Based on the findings that resulted from this study, it was concluded that the availabilities of ICT, the use of Information and Communication Technology, and the presence of ICT, when fully employed in the nation's educational sector will lead to a better, effective and efficient use of Information and Communication Technology in enhancing and improving science and technology based learning in educational sector thereby promoting national development.

Recommendations

In view of this research study, the following recommendations are hereby made.

1. Government should equip the nation's Educational Sector and agencies with adequate ICT tools and facilities to enhance and increase academic productivity.
2. The stakeholders in Government Educational sector and agencies should be regularly trained and retrained on the use of ICT tools and its facilities to enhance efficient service delivery.
3. Seminars and workshops should occasionally be organized to acquaint the staff, stakeholders and agencies in Government Educational sector on the practical use and applications of ICT tools and facilities thereby promoting national development.

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Assessment of Programming Skills Possessed By Computer Education Students In Federal College of Education (Technical) Asaba, For Self-Employment

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Abstract

This study was carried out to assess the programming skills possessed by computer education students in Federal College of Education (Technical) Asaba, Delta State for self-employment. The study adopted a descriptive survey design. The population of the study comprised of 130: 75 regular students, 30 part-time students and 25 lecturers in computer education department, Federal College of Education (Technical) Asaba. There was no sample size since the entire population was used because of its manageable number. The instrument used for data collection is a structured questionnaire, which was designed by the researchers and validated by two experts from the department of Computer Education, Federal College of Education (Technical), Asaba. One hundred and thirty (130) copies of the validated questionnaire items were administered on the selected students and lecturers in Computer Education Department of Federal College of Education (Technical) Asaba, Delta State by the researchers with the help of 3 research assistants and 118 copies were retrieved and analyzed using mean statistics. On the basis of the analysis, it was found amongst others that BASIC, C, C++, Java, and Visual Basic programming languages are taught to the students for self-employment, computer education students are not skillful in the programming languages taught for self-employment, lecturers' teaching approach, students' attitude, absence of practical classes and lack of instructional materials affect the acquisition of programming skills by computer education students. On the basis of the findings, the study recommended that lecturers should use more interactive teaching methods that will motivate the students to learn programming languages effectively, classroom environment should be made conducive to improve students' acquisition of programming skills amongst others for self-employment.

Keywords: Assessment, Programming, Skills, Computer education

Introduction

Science education is the teaching and learning of science to school children, college students, or adults within the general public. The field of science education includes work in science content, science process (the scientific method), some social science, and some teaching pedagogy (Justin, 2016). Science education aims at



producing scientists for national development as well as individuals who will be self-reliant and competent in their specialization. According to Hornby (2016) science education trains students who will be able to demonstrate knowledge, skills and attitudes that are sufficiently required to perform a given task. It is a functional ability to apply to practical situations the essential principles and techniques of a particular subject matter or field. Science gives complete ability and training intended to prepare students for various occupations. If an individual is well trained in science education with the necessary skills needed, especially in the use of computer, the person can possess necessary skills for self-employment (Adewunmi, 2017).

Computer Science Education is an interdisciplinary field; it is a course that deals with the teaching and learning of computer science; also it involves all the areas that impact on computer science philosophy, psychology, linguistics, natural sciences, and programming and how they intersect with the theory and practice of education (Roy, 2015). **Computer science education** or **computing education** is the science and art of teaching and learning of computer science, computing and computational thinking. In comparison to science education and programming education, computer science education is a much younger field. In the history of computing, digital computers were only built from around the 1940s; although computation has been in existence for centuries since the invention of analog computers. Computer education means gaining basic knowledge and skills to operate computers in order to perform desired jobs (Medua, 2020). Computer Education not only involves basic knowledge about computer, computer education extends to various branches of study in various fields and sectors. In the past, computer used the languages which were too complex for everyone to understand; only specific people having specific qualifications could be educated about and in computer. As technology has evolved, their applications and reach have widened due to the simplicity they provided to people and the sophisticated operations they can perform. As the human civilization further advanced in technology, more and more ubiquitous use of computers became certain, hence the integration of computers and programming in almost every sector of life.

Programming has been one of the highest advancing technologies in this era, which computer science education students must possess. Collectively known as “codes,” these instructions are written by computer programmers in order to solve problems or perform specific tasks. Programming generally results in a specific set of actions or the creation of a tangible result, whether it is a software application, a web page or even just an image displayed on a computer screen. In many ways, programming represents a perfect merging of art and science. Computer programming is little more than a set of instructions to facilitate specific actions. Based on the requirements or purposes of these instructions, computer programming can be as simple as adding two numbers. It can also be as complex as reading data from temperature sensors to adjust a thermostat, sorting data to complete intricate scheduling or critical reports or



taking players through multi-layered worlds and challenges in games (Ronald, 2015). Dennis (2015) pointed out that computer programmers and anyone connected with programming needs to keep up with technological development, competency and manipulative skills.

Computer programmers create instructions for a computer to execute by writing and testing codes that enable applications and software programs to operate successfully. Computer programmers use specialized languages to communicate with computers, applications and other systems to get computers and computer networks to perform a set of specific tasks (Philips, 2016). Most programmers typically decide on an area of specialization, and then learn the programming language that is most appropriate for that field. The most effective programmers combine knowledge, aptitude and technical capability with soft skills such as the ability to work as part of a team and to communicate well with others. Computer programmers need to have a wide range of skills in order to perform the many responsibilities of the position at the highest level of professionalism (Chima, 2020). Programmers are not expected to know every programming language in existence, but it would be beneficial to be proficient in at least two languages to increase their employable skills towards employment and career opportunities.

Skill is usually understood as an ability to do something well, either manually, mentally, or both. In contrast to terms that denote only potential for acquiring some ability (such as natural ability, talent, aptitude, or capacity), the term *skill* usually means actual competence that has been acquired by training, schooling, or practice. The concept 'skills' is used in several disciplines (most importantly economics, sociology, psychology, education, and ergonomics), and has many meanings, and is applied for different purposes and in a variety of contexts (Peters, 2014). The term *skill* is used mainly to refer to (1) a level of individual performance, in the sense of accuracy and speed in performing particular tasks, or (2) qualities required for successful performance in particular jobs and tasks. Economists and educational psychologists tend to use the concept of skill in the first sense: to describe the abilities acquired by an individual such as a worker, which may include cognitive skills, manual dexterity, knowledge, and social skills (Mcdon, 2016). In sociology, on the contrary, skills are often taken as qualities required of a particular job, in terms of the range and complexity of the tasks involved, level of discretion over work and time, and the knowledge and training needed to learn the job. Many sociologists thus view skill as a dependent variable and try to explain variations in the level of skill within occupations, economies, and/or over time. Mcdon (2016) stated that the employable skills are those skills that help someone keep a job.

There are various areas of employable skills which include programming skills; this is one of the skills required by a computer science education student for paid jobs or



self-employment upon graduation. With the proper acquisition of programming skills, graduates from computer science program can become self-employed for wealth creation. Computer programming skills according to Robert (2016) refer to the abilities and knowledge required to write, understand, and modify computer programs. These skills encompass a range of proficiencies that enable individuals to effectively design, implement and troubleshoot software solutions. Computer programming skills often combine creativity with technical and analytical elements. As with many other fields, computer programming skills can be grouped into hard and soft skills. “Hard skills” refer to measurable abilities that are developed over time through practice or study, while “Soft skills,” on the other hand, are abilities that enable people to fit into a working environment or work effectively with others (Mba, 2017). Aspiring computer programmers need to be able to demonstrate both types of skills; hence, this study determines the programming skills possessed by computer education students for self-employment in Federal College of Education (Technical) Asaba.

Statement of the Problem

Computer education is one of the fields of study that trains students to become self-reliant after graduating from school. This has been made possible through exposing the students to different aspects of computer including programming. Computer programming is one of the courses offered in computer education department in every institution of higher learning. Students who are exposed to different programming languages in the school are expected to later graduate and become self-employed and employers of labour instead of depending on government for white collar jobs. However, over the years, many students in the course of their studies, are taught different programming languages ranging from Beginners All Purpose Symbolic Instruction Code (BASIC), C, C++, Java, etc, and graduate from computer education without learning the necessary skills that will enable them become self-employed. This has brought about joblessness and increase in social vices in the society. It is against this backdrop that this study is carried out to assess the programming skills possessed by computer education students in Federal College of Education (Technical) Asaba, Delta State for self-employment.

Purpose of the Study

The major purpose of the study is to assess the programming skills possessed by computer education students in Federal College of Education (Technical) Asaba, for self-employment. The study specifically seeks to determine:

1. The programming languages taught in computer education department of Federal College of Education (Technical) Asaba.
2. The extent to which computer education students have mastered the programming languages taught in Federal College of Education (Technical) Asaba.

3. Factors affecting the acquisition of programming skills by computer education students in Federal College of Education (Technical) Asaba.
4. Strategies for improving the acquisition of programming skills by computer education students in Federal College of Education (Technical) Asaba.

Research Questions

The following research questions were raised to guide the study:

1. What are the programming languages taught in Federal College of Education (Technical) Asaba?
2. To what extent have computer education students gained the mastery of the programming languages taught in Federal College of Education (Technical) Asaba?
3. What are the factors affecting the acquisition of programming skills by computer science students in Federal College of Education (Technical) Asaba?
4. What are the strategies for improving the acquisition of programming skills by computer science education students in Federal College of Education (Technical) Asaba?

Methodology

The Descriptive Survey Research Design was adopted for this study. According to Nworgu (2015), descriptive survey is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals. The survey design was considered suitable for this study because it uses a representative sample of the entire population, and because it enabled the researchers to collect data and describe facts on the assessment of programming skills possessed by computer education students for self-employment in Federal College of Education (Technical) Asaba. The population of the study comprised of one hundred and thirty (130). Seventy five (75) regular students, thirty (30) part-time students and twenty five (25) lecturers in the Department of Computer Science Education, Federal College of Education (Technical) Asaba. There was no sample size since the entire population was used because of its manageable number. The instrument for data collection was titled "Questionnaire on assessment of programming skills possessed by computer education students for self-employment in Federal College of Education (Technical) Asaba." (QAPSCFCETA) and consisted of two sections 'A' and 'B'. The questionnaire had four points scale for the first cluster which were weighted as follows: SA - Strongly Agree (4), A - Agree (3), D Disagree (2), SD - Strongly Disagree (1). The bench mark was fixed at 2.50. Therefore, any item with the mean of 2.50 and above was accepted, while items with mean below 2.50 were rejected.

The research instrument was subjected to face validation by two experts from the department of Computer Education, Federal College of Education (Technical), Asaba. Experts were requested to examine the instrument in terms of clarity, relevance and appropriateness of the content. Their observations and suggestions were put into consideration while making the final copy of the instrument. A pilot study was carried out on 10 computer students and 5 computer lecturers from college of education, Warri, Delta state. Instruments were collected and analyzed using Pearson Product moment correlation to estimate the reliability which yielded a correlation of 0.75 which shows that the instrument is reliable. The instrument for data collection was administered by the researchers with the help of three (3) research assistants who were briefed on the purpose and nature of the study and how to distribute, collect and handle the retrieved copies. One hundred and thirty (130) copies of the validated questionnaire items were administered on the lecturers and students in computer education department, Federal College of Education (Technical) Asaba, Delta State by the researchers with the help of 3 research assistants and 118 copies were retrieved and analyzed using mean statistics and standard deviation.

Results

Research Question 1: What are the programming languages taught in Federal College of Education (Technical) Asaba?

Table 1: Programming language Skills Taught to computer education students for Self-Employment.

SN	Statements	\bar{X}	SD	Decision
1.	Basic programming language is taught to computer education students for self-employment.	3.17	0.8	Agreed
2.	Students are taught PASCAL Programming language for self-employment.	2.36	0.7	Disagreed
3.	C++ programming language is taught to computer education students for self-employment.	3.12	0.9	Agreed
4.	C programming is taught to computer education students for self-employment.	2.97	0.8	Agreed
5.	Java programming language is taught computer education students for self-employment.	3.00	0.7	Agreed
6.	Computer science students are taught FORTRAN programming language skill for self-employment.	2.23	1.1	Disagreed
7.	One of the programming languages taught in the school is visual Basic for self-employment.	2.52	1.0	Agreed
8.	Python programming language is taught to the students for self-employment.	2.34	0.8	Disagreed
Grand Mean		2.71		Agreed

Table 1 above presents the analysis of research question one on the programming languages taught. The result indicates that the respondents agreed with a mean response of 3.17 that basic programming language is taught to computer education students for self-employment. They also agreed with mean responses of 3.12, 2.97, 3.0, and 2.52 that students are taught C++, C, Java and Visual basic respectively for self-employment. However, the respondents are of the opinion that PASCAL, FORTRAN and Python are not taught to the students. The grand mean of 2.71 in the above table shows that Basic, C, C++, Java, and Visual Basic programming languages are taught to the students for self-employment.

Research Question 2: To what extent computer education students mastered programming languages skills for self-employment?

Table 2: *Extent to which computer education students mastered programming language skills for self-employment*

SN	Statements	\bar{X}	SD	Decision
9.	Students have mastered Basic programming language skill for self-employment.	3.14	1.0	Agreed
10.	Computer science students are skillful in Pascal Programming language for self-employment.	2.08	0.9	Disagreed
11.	C++ programming language is one of the programming languages that students are skillful in for self-employment.	2.10	0.9	Disagreed
12.	Students are also conversant with C programming skill for self-employment.	2.15	0.8	Disagreed
13.	Students have the mastery of Java programming language skill for self-employment.	2.09	0.9	Disagreed
14.	Computer science students are familiar with FORTRAN programming language skill for self-employment.	2.38	1.1	Disagreed
15.	One of the programming languages computer science education students skillful in visual Basic for self-employment.	2.17	0.8	Disagreed
16.	Computer science education students are skillful in Python programming language for self-employment.	2.20	0.9	Disagreed
Grand Mean		2.29		Disagreed

Table 2 above presents the result of the analysis of research question two on extent to which computer education students mastered programming languages skills for self-employment. The respondents are of the opinion that students have mastered Basic programming language skill for self-employment judging from the mean response of 3.14. The mean responses of 2.08, 2.10, 2.15, 2.09, 2.38, 2.17 and 2.20 shows that computer education students are not skillful in Pascal Programming language, C++, C, Java, FORTRAN Visual basic and Python programming languages respectively for self-employment. According to the respondents with a mean response of 3.14, Basic programming language is the only programming languages that students are

skillful in for self-employment. Grand mean of 2.29 shows that computer education students are not skillful in the programming languages taught for self-employment.

Research Question 3: What are the factors affecting the acquisition of programming skills by computer education students in Federal College of Education (Technical) Asaba?

Table 3: Factors affecting the acquisition of programming skills by computer education students in Federal College of Education (Technical) Asaba.

SN	Statements	\bar{X}	SD	Decision
17.	Lecturers' approach to teaching affects the acquisition of programming skills by computer education students negatively.	2.95	1.0	Agreed
18.	Students attitude towards programming languages affect the acquisition of skills in the courses negatively.	3.19	0.7	Agreed
19.	Classroom environment affects the acquisition of programming skills by computer education students.	2.47	0.8	Disagreed
20.	Absence of practical classes of programming courses affect the acquisition of skills by students in the courses negatively.	3.04	0.7	Agreed
21.	Lecturers' attitude towards the teaching of programming affects the level of mastery of those courses by students.	3.25	0.9	Agreed
22.	Unavailability of instructional materials affect the acquisition of programming skills by computer education students.	2.86	0.8	Agreed
Grand Mean		2.96		Agreed

The analysis of research question three on the factors affecting the acquisition of programming language skills shows that lecturers' teaching approach, students' attitude towards programming, absence of practical classes, lecturers' attitude and unavailability of instructional materials affect the acquisition of programming skills by computer education students negatively with mean responses of 2.95, 3.19, 3.04, 3.25, and 2.86 respectively. They however disagreed that classroom environment affect the acquisition of skills by students negatively with a mean response of 2.47. Grand mean of 2.96 indicates that lecturers' teaching approach, students' attitude, absence of practical classes, lecturers' attitude and lack of instructional materials affect the acquisition of programming skills by computer education students.

Research Question 4: What are the strategies for improving the acquisition of programming skills by computer education students in Federal College of Education (Technical) Asaba?

Table 4: Strategies for improving the acquisition of programming skills by computer science education students in Federal College of Education (Technical) Asaba

SN	Statements	\bar{X}	SD	Decision
23.	Lecturers should use more interactive teaching methods that will motivate the students to learn programming languages effectively.	3.08	1.0	Agreed
24.	Classroom environment should be made conducive to improve students' acquisition of programming skills.	3.50	0.9	Agreed
25.	Lecturers should endeavour to enlighten students on the available programming based job opportunities.	2.94	1.0	Agreed
26.	The college management should provide necessary materials for effective acquisition of programming skills by the students.	3.25	0.9	Agreed
27.	There should be practical teaching of programming languages to improve the acquisition of skills by students.	3.35	1.1	Agreed
28.	Students should be encouraged to practice programming languages every day to improve their skills in those courses.	2.87	0.8	Agreed
Grand Mean		3.17		Agreed

On the strategies for improving the acquisition of programming skills by computer education students, the result shows that the respondents are of the opinion that lecturers should use more interactive teaching methods that will motivate the students to learn programming languages effectively, lecturers should teach the students in more conducive classroom environments, educate the students on employable programming skills, introduce more practical teaching, encourage students to practice more often and of course management should ensure the availability of teaching resources as shown in their mean responses of 3.08, 3.50, 2.94, 3.25, 3.35 and 2.85 respectively. The grand mean of 3.17 shows that when lecturers use good method of teaching, classroom environment is made conducive, students are encouraged and necessary materials are provided, it will help to improve the acquisition of programming skills by the students for self-employment.

Discussion of Findings

The first finding according to table 1 revealed that BASIC, C, C++, Java and Visual Basic are the programming languages taught to computer education students for self-employment in Federal college of education (Technical), Asaba. This is in agreement with Justin (2016) who found that BASIC, C, C++, FORTRAN, Java, Pascal are programming languages taught in colleges of education in Nigeria. Olaniyi (2017) also found that the programming languages mentioned above are part of the courses taught in colleges of education in Nigeria for self-sufficiency. This indicates that the students are taught those programming languages to help develop their programming skills for self-employment after graduation. Another finding revealed that computer education students are not skillful in the programming languages taught for self-employment. This is in line with Justin (2016) and Olaniyi (2017) who in their

respective studies found that computer education students need more than just the classroom lectures in order to become more skillful in the programming. That shows that students graduate from computer education department without acquiring the necessary programming skills that will enable them to become self-employed.

The result of the findings further revealed that lecturers' teaching approach, students' attitude, absence of practical classes, lack of instructional materials and lecturers' attitude are all responsible for the non-acquisition of programming skills by computer education students. These findings are in line with those of Olaniyi (2017) who found that the teaching and learning of programming languages is affected by many factors, some of which are students' lack of interest, method of teaching used, and lack of instructional materials. Furthermore, the finding revealed that when lecturers use a more interactive method of teaching, classroom environment is made conducive, students are encouraged to practice more often and necessary teaching resources are provided, it will help to improve the acquisition of programming skills by the students for self-employment. This is in line with Justin (2016) who suggested that students should be encouraged to learn the programming languages, better methods that can help to sustain students' interest and instructional materials should be made available for the effective teaching and learning of those courses.

Conclusion

The world has become a global village where people get information at anytime and anywhere. That is why the knowledge of computer has become very necessary especially that of programming languages. This is because programming is a fast-growing field with numerous job opportunities. Many programming languages such as Basic, Java, C++, Visual basic and so on are taught in colleges of education, yet many students graduate without possessing the necessary skills that will enable them become self-employed. This is as a result of many factors some of which are lecturers' teaching approach, students' attitude, absence of practical classes amongst others. Based on the findings of this study, it was concluded that the use of a more interactive teaching approach with available teaching resources are critical for acquiring and improving programming skills by computer education students in FCE(T), Asaba.

Recommendations

On the basis of the findings, the researcher therefore recommends that:

- i. Lecturers should use more interactive teaching methods that will motivate the students to learn programming languages effectively.
- ii. The college management should provide necessary teaching resources or materials for effective acquisition of programming skills by the students.
- iii. Lecturers should engage more in practical teaching of programming languages to improve the acquisition of skills by students.
- iv. Students should be encouraged to practice programming languages more often to improve their skills in programming.



- v. There should be training and re-training of lecturers on the practical aspect of computer programming for effective skill acquisition.

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Plastic Waste Menace and Management through Construction for Environmental Sustainability

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Abstract

The development and use of plastics show a continuous increase in production over times, and there is no clear pointer to when the change from plastic based materials will shift to another eco-friendly material as a substitute. The effects of plastic waste to live and environment portend far reaching danger. This review presents the menace and management of plastic waste for environmental sustainability through construction. It examines the management methods commonly used and their implications; including the danger of landfill and incineration and discusses viable methods plastic waste can be used in construction. It concluded that incineration and landfill should be highly discouraged since they contribute additional pollutions to the environment. Rather, the management of plastic waste should be directed towards using the waste in the production of construction materials which is the healthier, sustainable and economic method.

Key words; construction, environmental sustainability, management, menace, plastic waste

Introduction

The trend of plastic production throughout the world shows a continuous increase over times, and there is no clear indicator when the transformation from plastic based production will shift to an alternative or a substitute (Kamaruddin, Abdullah, Zawawi & Zainol, 2017). In many cases plastics are thrown away after one use, especially in packaging and sheeting, but because they are durable, they persist in the environment (Hopewell, Dvorak, & Kosior, 2009). Further, as increase in plastic production and use in emerging economies continue, waste management infrastructure need to be developed accordingly (Uwaegbulam, Nwannekanma & Gbonegun, 2018). Unfortunately, that is lacking and the properties of plastic that make it so valuable also make its disposal problematic.

Plastic Waste (PW) management has become a global predicament, requiring adequate attention in order to solve the world's resource and energy challenges. In line with this, the World Environment Day celebration had its theme for 2018 as "Beat Plastic Pollution" because plastic pollution is a global and raising concern. However, as the use of plastic in modern society has increased, so have the environmental impacts associated with its production and disposal? It is ultimately therefore important to address plastics pollution, as it is highly relatable for the achievement of some Sustainable Development Goals.



Consequently, the use of plastic waste in construction is considered to be a better option for alternative plastic waste disposal, due to its economic and ecological advantages. Therefore, finding applications in construction where plastic wastes are suitable will offer a sustainable way of dealing with the menace. The construction industry is a promising sector where Plastic Waste can be beneficially used for various applications, mainly because it is the largest industry in different economies and the highest consumer of raw materials (Awoyera, & Adesina, 2020). Subsequently, this article reviews plastic waste menace and management for environmental sustainability through construction.

Nature of Plastics

Plastics are made from non-renewable oil resource which has the insolubility of about 300 years in nature, hence, it is considered as an ecological waste and environmental pollutant (Jaladdrin, 2017). Plastics are synthetic organic materials produced by polymerization. Plastics are of high molecular mass that can be molded or extruded into desired shapes. They are classified as thermoplastics and thermosets. Thermoplastics soften when heated and molded with pressure when in molten state and becomes hardened when cooled to retain the shape. It includes various products such as Polypropylene (PP), Polyethylene Terephthalate (PET), Low density polyethylene (LDPE), High density Polyethylene (HDPE etc., while thermosets on the other hand are solids that cannot be melted rather decompose on heating (Majka & Pielichowski, 2011). Products of this category are Nylon, Bakelite, etc.

The life cycle of plastics begins from the extraction of ethylene from crude oil or natural gas to its disposal as waste after usage. Several substances, as well as polymers, are added in the production of plastics to improve performance, and or reduce cost (Ikpe & Owunna, 2017). There are different varieties of plastic that can be produced from resources such as petroleum. This is generally done by converting long chains hydrocarbons along with some additives that can be easily molded into desired finished products. Plastic are available as polymer but to obtain its various forms, it is generally broken down in the presence of a catalyst to form monomers such as Vinyl, Propylene, Styrene, Benzene, etc. (Kamaruddin, Yusoff, & Ahmad, 2015). Plastics are of five major categories: Polyethylene (PE), Polyethylene terephthalate (PET), Polypropylene (PP), Polystyrene (PS), Polyvinylchloride (PVC) (Ayo, Olukunle, & Adelabu, (2018).

Plastic Production and Consumption

Over the past 50 years, there have been a global increase in the production of plastic, from 2 million metric tons in 1950 to 381 million metric tons in 2015, and it is anticipated to double in the next 20 years (Hub, 2018). The total global production of



plastics up to 2018 was estimated at 8,300 million metric tons (Royer, Ferron, Wilson, & Karl, 2018), with 64 million metric tons produced in Europe alone. China is one of the largest producers of plastics in the world, accounting for more than one quarter of the global production (Statistica, 2018).

The implication is that as more resources are being used to meet the increased demand for plastic, more plastic waste is being generated (United Nations Environmental Protection, 2018). Annually, over 280 million tons of plastics are produced and almost 75% of the demand comes from four major sectors: packaging, construction, automotive and electrical or electronics (Thevenon & Oliver, 2014). The use of plastic has increased twentyfold in the past half-century and is expected to double again in the next 20 years. Globally, plastic waste constitutes more than 60% of the total global municipal solid waste (MSW) of which 22% are recovered and 78% disposed (Ogwo, Obasi, Okoroigwe, & Dibia (2013; Ayo, Olukunle, Adelabu, 2018).

In Nigeria, packaging industry has accounted for 12 percent of the 4 billion recorded by Middle East and African markets in the last five years (Hub, 2018). The total amount of plastics imported into Nigeria from 1996-2014 was estimated to be 23.4 million tons. Plastics produced in Nigeria are manufactured from imported raw materials or from recycled (Elias & Omojola, 2015). The per capita consumption of plastics in Nigeria has grown by about 5% annually over the past ten years, from 4.0 kg in 2007 to 6.5 kg in 2017 and was estimated to be 7.5 kg in 2020 (Brandspur, 2017).

The drivers for the growth of plastic applications include; low cost, excellent oxygen/moisture barrier properties, bio-inertness and light weight make them excellent packaging materials (Olanrewaju & Oyebade, 2019). The uses of plastics in preservation and distribution of food, household activities and appliances are too many to mention. Plastics have been specially designed to form an integral part of the communication and electronics industry, especially in the manufacture of chips and compartments. Besides it is widely use in packaging, automotive and industrial applications, widely used in medical delivery systems, artificial implants and other healthcare applications, water purification and removal of bacteria etc (Verma, Vinoda, Papireddy, & Gowda 2016; Okon, 2018). They are also used as alternative energy systems such as fuel cells, batteries (Babayemi, Ogundiran, Weber & Osibanjo, 2018).

Menace of Plastic Waste

Plastics have become an integral part of our lives; its wide use in various sectors and its ever-expanding applications is due to its enormous benefits to the society



(Olanrewaju & Oyebade, 2019). The amounts of plastics consumed annually have been growing. Consequently, plastic waste is now one of greatest threat to ecosystem where lives are being endangered. United Nations Environmental Protection (2018) stressed the environmental implications of plastics consumed by the world population; to have surpassed 7 billion in 2011, and is forecast to exceed 9 billion by 2050. Subsequently, it is feared that the growing demand for resources will facilitate an increase in plastics waste generation that will contribute to deterioration of the natural environment and climate change (Ogwo, Obasi, Okoroigwe & Dibia, 2013).

According to Awoyera, and Adesina, (2020) plastic wastes generated in large quantities have become a great menace to the sustainability of our planet. It has been reported that a great damage befalls ecology, economy, and structural aesthetics when plastic debris enters into oceans (Jambeck, Denise, Brooks, Friend, Teleki, Fabres, Beaudoin & Wilcox, 2017). About 300 million metric tons of plastic wastes have been estimated to be generated annually (Singh & Sharma, 2016). According to Daftardar, Patel, Shah, Gandhi, and Garg (2017) waste in form of plastics increasing day by day, but a permanent solution to it is still not found. This is because the modern lifestyle, alongside the advancement of technology has led to increasing amount and type of plastic waste being generated, leading to a waste disposal crisis (Jaivignesh & Sofi, 2017). Though, plastic is fit for a wide variety of applications, many establishments are now faced with the increasing problem of how to dispose a huge volume of plastics waste. The rapid growth in the Nigerian population comes with increase in waste generation (Sule, Ismaila, Osagie, Buba, Farida, & Waziri, 2017).

Nigeria generates around 32 million tons of solid waste annually, out of which only 20-30% is collected (Bioenergy consult, 2016). The rest is disposed in open spaces, road sides and within residential buildings. In Nigeria, less than 12% of plastic waste is recycled and about 80% of plastic waste goes to landfills and dump sites (Babayemiet *al.*, 2018). Cities choose to dump solid waste in dump yards where waste is either buried or left in place. The common act of dumping is particularly due to the lack of awareness of the need to discard an enormous amount of wastes generated from households and surrounding areas (Olanrewaju & Oyebade, 2019).

Since the amount of plastics consumed annually is growing steadily the disposal has being a very serious challenge all over the world (Dhawan, Mohan, Bisht, Kumar & Kumari, 2019).

It has been estimated that, 6.3 billion tons of plastic waste has been produced worldwide from 1950 to 2018, of which only 9% and 12% have been estimated to be recycled and incinerated respectively (Jaivignesh & Sofi, 2017). It is also estimated



that at least eight million tons of plastic end up in the oceans every year (Darshan & Gururaja, 2017). According to Hub (2018) more plastic have been produced in the last 10 years than in the whole of the 20th century, and every piece of plastic ever produced still exists today. Thus, it is empirically predicted that there will be more plastic waste than fishes in the world's ocean by 2050 and this portends a far-reaching danger (Olanrewaju & Oyeade, 2019).

Plastic Waste Management

Plastic waste now poses a serious environmental risk to the modern way of living. Thus Nigeria has been making efforts to manage the plastic waste through research and development and establishment of waste management centers across the country. There is now a global effort through researches on how to manage plastic waste through disposal and applications in construction industry.

Incineration and Landfill

Incineration of plastic waste is an open burning and it is a major source of air pollution so dangerous to live (Verma, Vinoda, Papireddy, & Gowda, 2016). Poisonous gases are emitted upon incineration or burning (Omosebi, Abas, & Oladipupo, 2021). Toxic gases like Dioxins, Furans, Mercury and Polychlorinated Biphenyls enter the atmosphere. Thus, poisonous substances released pose a threat to all life and environment including human, vegetation, and animal health. Polystyrene is harmful to the Central Nervous System, the hazardous brominated compounds act as carcinogens and mutagens, Dioxins settle on the crops and in waterways where they eventually enter into food and hence the body system (Verma, Vinoda, Papireddy, & Gowda, 2016). Thus, burning of plastic wastes increases the risk of heart disease, aggravates respiratory ailments such as asthma and emphysema and causes rashes, nausea or headaches, and damages the nervous system. Land filling of plastic waste requires a large space; reduces the land lifespan and causes persistent pollution problems (Kamaruddin, Abdullah, M, Zawawi, & Zainol, 2017) because of their non-biodegradability nature. So, incineration and landfill of plastic wastes have posed a major threat to the environment causing environmental pollution.

Recycling of plastic waste

Ishaiba (2015) descriptions of types of plastic and their potential recycling techniques are as shown in Table 1. According to Ishaiba (2015) the method used in the recycle seems uneconomical because the recycled plastic is not always durable and thus there is growing demand for plastic from the original product. This has continued to increase the amount of plastic waste hence necessitated a better method of plastic waste management.

Managing Plastic Waste through Construction

Table 1: *Plastic types and their potential recycling method*

Plastic Source	Characteristics	Common Use of Virgin Plastic	Common use for Recycled Plastic
Polyethylene Terephthalate (PET)	Clear hard plastic, suitable for fibre	Soft drink and mineral water bottles	Clear and soft film for Packaging and wrapping, rug fibers, rain coats
Low density polyethylene (LDPE)	Soft, flexible plastic, milky white, unless a pigment is added	Lids of food containers, garbage bags, and rubbish bins	Soft film, wrapping industry, plant packaging and nurseries bags
High density Polyethylene (HDPE)	Commonly used plastic in white or other colour	Puckered shopping bags, milk storage bags (freeze)	Compost bins, detergent bottles, crates, and mobile rubbish bins
Unplasticised Polyvinyl chloride (UPVC)	Hard rigid plastic, clear Type	Sanitary piping, plumbing pipes and fittings	Dishwasher bottles, toiletries detergent bottles, tiles, and plumbing pipe fittings
Plasticized Polyvinyl chloride (PPVC)	Flexible, clear, elastic Plastic	Garden hose, shoe, soles, blood bags and tubing	Hose inner core, and industrial flooring
Polypropylene (PP)	Hard, but flexible Plastic	Ice-cream containers, potato crisp bags	Compost bins, kerbs side recycling crates, and worm factories
Polystyrene (PS)	Stiff but brittle plastic.	Cheap, transparent kitchen ware, light fittings, bottles, toys, and food containers	Laundry pegs, coat hangers, and video/CD boxes
Polyester (EPS)	Clear in nature and Glossy Foamed, lightweight, energy absorbing, and thermal insulation	Hot drink cups, and takeaway food containers	spools, rulers, and video/CD boxes
Polyamides (PA)	Nylons	fibers, toothbrush bristles, and fishing lines	

Source; *Ishaiba (2015)*

As urbanization and population continue to grow, there will be a corresponding increase in the demand for various infrastructures to be constructed. Therefore, the use of Plastic Waste (PW) for different construction applications seems to be one of the effective ways to tackle the sustainability issue and meet future infrastructure demand (Awoyera, & Adesina, 2020). Plastic waste as cementitious based materials,

such as cement mixtures appear to be a better option for alternative plastic waste disposal (Kamaruddinet.al, 2017). This is due to its economic and ecological advantages as it can replace certain portion of aggregate in concrete production. Besides, some variation of concrete using plastic waste as aggregate have been certified good material for lightweight concrete pavement with low strength application.

Plastic Waste in Road Construction

The use of PW in road construction has since attracted the attention of researchers and therefore has been explored in many forms. For instance, Arulrajah, Yaghoubi, Wong, & Horpibulsuk (2017) explored the viability of using PW granules alongside demolition wastes as mixtures for road construction. The results shows that the addition of PW lowers the bearing capacity, stiffness, and stiffness modulus of the resultant material, however, the performance was still satisfactory. The lower performance in the properties of the mixtures was attributed to the smooth surface of the PW granules. Again, the use of low-density polyethylene (LDPE) and high-density polyethylene (HDPE) plastics have been found to be the most promising in asphalt blends compared to other types Kumi-Larbi, Yunana, Kamsouloum, Webster, Wilson, & Cheeseman, 2018).

Sasidharan, Torbaghan and Burrow (2019) observe that, using plastics waste in road construction is a relatively new idea. Though, plastic waste has potential for use in bituminous road construction as its addition in small doses (about 5-10% by weight of bitumen) helps in substantially improving the stability, strength, fatigue life and other desirable properties of bituminous mixes, leading to improved longevity and pavement performance (Kalantar, Karim & Mahrez 2012; Vasudevan, Sekar, Kannan, & Velkennedy 2012; Indian Road Congress, 2013).

Laboratory and field performance studies testified that using plastic waste in bituminous mixes increases durability and results in higher resistance to deformation and water induced damage, indirectly contributing to user satisfaction and accident reduction (Khursheed & Singh, 2017). Using waste plastic for road construction also contributes to longer road service life (Sojobi, Nwobodo & Aladegboye, 2016).

The use of molten plastic as a partial replacement of bitumen on road construction reduces the waste menace in the environment and produces a durable road. In the work of Yadav and Chandrakar (2017), it was established that, the strength and performance of the road built with higher percentage of plastic waste increase significantly and also prevents moisture absorption and oxidation of bitumen by entrapped air and therefore shows better durability properties. There are several benefits of using waste plastics as a modified binder in bituminous road construction

as recorded by Trimbakwala (2017), some of which include; improved resistance to surface-initiated cracking, management of plastic waste, co-friendliness in construction and maintenance of balance environment.

Plastic in Concrete

The two main forms of plastics waste commonly used in concrete as building materials according to Ozbakkaloglu (2016) include; plastic aggregate (PA) and plastic fiber (PF). PAs are employed to replace coarse aggregates (CA) and fine aggregates (FA), the PA normally possesses lower bulk density than granite, limestone or basalt (Kamaruddin et al., 2017). Therefore, they are preferably being employed for lightweight concrete and can be obtained by applying mechanical recycling method.

Plastic Fibers (PFs) on the other hand are used as reinforcement which can replace common steel fiber to improve mechanical strength and durability (Yin, Tuladhar, Shi, Combe, Collister & Sivakugan, 2015). The major drawback of common steel fiber as concrete reinforcement according to Kamaruddin et al. (2017) has being its susceptibility to corrosion especially on concrete surface when exposed to aggressive environment without having adequate concrete cover for protection.

In concrete, the development of plastic aggregates from polystyrene, High Density Polyethylene (HDPE), polyethylene terephthalate (PET) and other plastics have been used in concrete to improve the properties and reduce cost of the concrete (Pramod, Mali, Ganesh, Kumavat, 2014). PW has been used successfully to replace conventional aggregates in concrete without any long term detrimental effects and with acceptable strength development (Suhad, Mohammad, Abdul-Sattar, & Malalla, 2016). Though, it was observed that the compressive strength of the concrete decreases with increase in plastic aggregates (Karthikeyan, Balamurali, Barath, Manoj & Janarthanam, 2019), it was however recommended for concrete work of less importance and small construction works like foot path, herbs, paving stones (Jangid, Panday, Yadav, Rawat & Asawara, 2019).

Plastic Wastes as Binder in Composite Tiles

Composite roof tiles development with plastic waste as binder is now beginning to gain attention. Eng et al. (2018) developed a hydrophobic composite roof tiles using recycled plastic materials and found that the roof tile can be compared with other roof tiles in terms of light weight, strength, and water tightness. The use of PET in plastic composite tiles has both good strength and absorptive property for roof tiling (Bamigboye, Ngene, and Ademola. & Jolayemi. 2019). Other works also confirmed it as suitable for roofing (Gaggino, Krieger, Filipp'yn, Amono, Lar'ya., & Peisino 2018). Further, the use of plastic waste as a binding agent for the manufacturing of paving tiles instead of cement has been proved useful (Puttaraj, Basavaraj, Gagan, Shivu & Manjunath, 2020).

Conclusion

Plastic waste is a threat to the environment and lives. It affects aquatic life, human health, and influences climate change. As more plastic waste are generated, incineration and landfill should be highly discouraged since these contribute additional pollutions to the environment. However, the management of plastic waste should be directed towards using the plastic waste in the production of construction materials which is the healthier, sustainable and economic method.

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Promoting Green Chemistry Based Education for Sustainable National Development

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Abstract

This paper focused primarily on green chemistry; the background to its emergence, its definition, origin, importance and need. The benefits of green chemistry were listed as waste reduction, efficient use of natural resources, its positive effects on health, safety and environment (HSE), use of benign feedstocks and renewable sources of energy, as well as an ideal platform of innovation for sustainable development among others. The paper also discussed numerous innovations and accomplishments in green chemistry, barriers and impediments against implementation and adoption of green chemistry principles by industry, academia and government. These barriers were enumerated as economic, technical, cultural, organizational etc. Ways to overcome these barriers and thus promote the implementation of green chemistry practice in the industry and academia were discussed as well. The conclusion drawn, was that implementation of green chemistry principles in Nigeria will not only require the collaborative effort of government, industry and academia, but will also move the chemical sector to the center of various challenging issues of the present and future generations and thus promote development towards more sustainable solutions.

Keywords: Green Chemistry, Education, Sustainable National Development.

Introduction

Chemistry has played, and continues to play a fundamental role in almost every aspect of modern society (Pasquate & Michael, 2019). The range and varieties of chemical products in today's society is enormous. These products make an invaluable contribution to the quality of human lives (Umesh, 2023). In medicine, the design and manufacture of pharmaceutical products has enabled us to cure diseases that have ravaged humanity throughout history (Dara & Umare, 2013). The world's food supply has increased dramatically, as a result of synthesis of crop protection and growth enhancement chemicals. Petroleum products have revolutionized the transportation sector, semiconductors have made possible computers and other electronic devices. In fact, chemistry changed forever the quality of man's life (Surabhi, 2021).

In recent times, however, the negative effects of chemistry have become obvious. There is no denying that in years past, and even at present, chemistry (chemical knowledge and practice) has been abused and/or misused in many respects (Sri,



Ravichandran, & Suneetha, 2021). This has resulted in the release of toxic substances and non-biodegradable materials into the air, water and land. These discharged substances have caused the deterioration of the environment and untold negative impact on plants, animals and humans.

The biggest challenge for the chemists and the chemical enterprise in this twenty first (21st) century is to design chemical manufacturing processes in such a way that the waste products are reduced to the minimum. This means that chemists should continue to provide the benefits of chemistry to humanity without the adverse health safety and environmental effects. This has led to the practice of chemistry moving steadily towards environmental friendliness and resource sustainability. "This practice of chemistry in a manner that maximizes its benefits while at the same time minimizing its adverse impacts has come to be known as green chemistry (United Nations, 2017).

Green Chemistry: Definition and Concept

The concept of Green Chemistry (GC) was coined by Paul Anastas of United States of America Environmental Protection Agency (USEPA) in 1991 and is known as the father of G C (Dara & Umare, 2013). GC is defined as the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. International Union of Pure and Applied Chemistry (IUPAC, 2010), defines GC as the invention, design and application of chemical products and processes to reduce or eliminate the use and generation of hazardous substances.

GC represents an innovative approach in chemistry practice, aimed at providing insight towards the effective use of raw materials, the optimization of waste streams, and the removal of hazardous reagents and solvents, in the manufacture and application of chemical products. It is an umbrella concept that has grown substantially, since it fully emerged about three decades ago. It is concerned with the development of processes and technologies that result in more efficient chemical reactions, that generate little waste and fewer environmental emissions than traditional chemical reactions do. GC encompasses all aspects and types of chemical processes that reduce negative impacts to human health and the environment relative to the current state-of-the-art practices, in traditional chemistry (Sunita, 2013). According to Sri, et al (2021), Gc embodies two main components. First, it addresses the problem of efficient utilization of raw materials and the concomitant elimination of waste. Second, it deals with the issue of health, safety and environment (HSE) associated with the manufacture, use and disposal or reuse of chemicals.

GC is commonly presented as a set of twelve (12) principles. The principles include instructions for professional chemists to synthesis new chemical compounds and new technological processes. Adhering to these principles prevents pollution and waste, leads to synthesis of chemicals in less hazardous and more efficient ways,



promotes the use of renewable, biodegradable and benign feedstocks; and in addition leads to the design of safer chemicals.

The Need for GC

The global chemical industry releases about five (5) billion tons of chemical wastes annually to the environment, and also spends over three hundred billion dollars annually for treatment, control and disposal of these chemical wastes, according to (United States Environmental Protection Agency [US EPA], 2019). Those poses a formidable challenge for chemists, chemical engineers and other stakeholders to review the design, manufacture and use of chemicals and then to further accomplish improvements or change in the design of new products and processes. These new ideas and innovations are essential to meeting industry and society's growing needs. For a continually growing population with rapidly depleting natural resources, increasing energy prices and numerous other drivers, are forcing scientists and engineers to seek for new and sustainable sources of resources for future chemicals, energy and materials for production. In fact, the innovation must be planned and implemented in such a way, that they are sustainable both economically and environmentally. From the stand of environmental protection, many industries globally have made significant progress in reducing emissions. Yet, even with these improvements, the impact of industrial processing, use and disposal of chemicals on environment is staggering.

The environmental protection in many countries was based on promulgation of status and regulations, and implementing them using command and control approach. In order to implement the environmental regulations, industries had to install a variety of waste handling, treatment, control and disposal systems, which require new equipment with high capital cost.

On the societal level, this means increase in the price of the consumer goods. In addition, the true costs of the environmental impacts due to the manufacture, use, and disposal have not been fully incorporated into the price of the goods produced. These costs include site remediation, ecosystem destruction and health impact. It is precisely in this context, that green chemistry emerged to provide the best opportunity for manufacturers and users of chemicals to carry out their works in the most economical and environmental beneficial way. Gc is already demonstrating the potential to develop new technology, techniques and methodology that will enable industries to minimize impact of chemical production and usage.

Innovations/Accomplishments in GC

The research, development and implementation of GC has led to significant economic gains for many chemical firms with accompanying HSE benefits for society. The breadth of GC's applicability seen through its many areas of innovative accomplishments spanning agriculture, energy, materials, electronics, automotive,

consumer goods etc. Several industrial sectors have been true pioneers in their adoption of GC principles by recreating the approach to designing the next generation of chemicals and materials. These include polymer manufacturers, textile producers and pharmaceutical developers.

A number of noteworthy successes that is accomplishments resulting from adoption of GC principles, which can serve as illustrative examples to the chemical community and the entire public as to potentials of GC. Some of these accomplishments; adapted from Sri et al (2021) include:

1. Synthesis of a dramatically more effective fire extinguishing agent that eliminates halon and utilizes water in combination with an advance surfactant.
2. Production of large scale pharmaceutical active ingredients without the typical generation of thousands of pounds of toxic waste per pound of product.
3. Elimination of arsenic from wood preservatives that are used in lumber applied to decks and playground equipment.
4. Higher performance automotive coatings that remove the substantive lead content and replace with the relatively benign element yttrium.
5. A class of pesticides that focus exclusively on the unique characteristics of the target pest and biodegrading to innocuous by-products after use or active time in the environment.
6. Making of computer chips using chicken feathers. The process involves converting the protein, keratin found or obtained from the feather to make fiber form that is both light and tough enough to withstand mechanical and thermal stresses. The result is feather-based printed circuit board that actually works at twice the speed of traditional circuit board.
7. Replacement of perchloroethylene, a known ground water contaminants and a suspected carcinogen with liquid carbon (IV) oxide and surfactant for dry-cleaning clothes.

There are other GC innovations that are at different stages of development. Few are listed below, as adapted from Sunita (2013).

Synthesis, Use and Development of Alternative Solvent

Solvents are used in almost all areas of chemistry and in variety of unit operations such as extractions dissolution of solids for ease of handling etc. Many of the commonly used solvents are volatile organic compounds (VOCs). These VOCs pose serious HSE concerns. However, the principles of GC guide us to use less of VOCs, if at all, if not, to use safer, more environmentally friendly solvents. This is to help reduce or eliminate the negative impacts of VOCs. As a result, a class of safer solvents called green solvents has been synthesized. These green solvents or biosolvents (since they derived from agricultural/biological sources) are

environmentally friendly solvents. Ethyl lactate, for example, is a green solvent derived from processing corn. It is mainly used in the paints and coating industry, and have numerous attractive advantages such as 100% biodegradable, easy to recycle, non-corrosive, non-carcinogenic and non-ozone depleting properties.

The use of water as solvent for organic reactions is one of the finest solutions to the problem of solvent toxicity and disposals. The chemistry in natural system (i.e. biochemical reaction) is based on water. The use of water as solvent for synthetic chemistry hold great promise for the future, in terms of its cheaper and non-hazardous, non-toxic, non-flammable, and renewable nature

Synthesis and Use of Biodiesel or Biofuels

Other than long-term supply issues, the main drivers for moving away from fossil fuels resources is pollution. As a result, there is therefore growing need for alternative energy feedstock to replace fossil resources. There are several options of renewable and sustainable energy sources including wind, solar, water as well as biomass. The production of biofuel from biomass is a promising possibility. As the name indicates, biofuels is produced exclusively from cultivated plant oil. Most research into biofuel is focused on vegetable oils such a soya bean, sunflower, palm oil and rap seed oil. Palm oil can now compete favourably with mineral oil, even in the production of petrol and natural gas. The new drilling fluid based on plant-derived esters of palm oil is an example. The resulting rock powder can be returned to the sea without any HSE concerns. The advantages of using biofuels are many;

- a. It is a fuel from renewable resource
- b. Contrary to fossil fuel diesel oil, the combustion of biodiesel does not generate waste like Sulphur compound.
- c. Biofuel generally does not increase the amount of carbon (IV) oxide, (CO_2) in the atmosphere.

Use of Biocatalysts and Alternative Feedstock

Biocatalysts by virtue of its merits such as selectivity, sustainability and environmental safety, holds a strong promise to discover new and, novel production pathways for very useful chemical compounds. Recently, new polymeric materials are being produced from biological/agricultural wastes, such as polysaccharides using biocatalytic, transformation. These polymeric substances often called eco-plastics are produced annually from corn waste in a bio refinery, and are used mainly for routine packaging. These processes simultaneously address several GC objectives and environmental concerns such as;

- Use of environmentally benign feedstocks
- Use of biocatalyst transformation rather than the organic monomers and harsh environmental conditions
- Addresses the HSE concerns of persistent polymers and plastics by paving the way for manufacture of biodegradable polymers and plastics.



Examples of GC's innovation and accomplishments listed above illustrate how GC impacts a wide array of fields and offer a pathway to a better world.

GC and Sustainable Development

Fundamental to the GC concept and principles is the idea of sustainability. GC provides an ideal platform of innovation for sustainable development. Presently, the chemical enterprise and practice, presents challenges to the health, safety, environment, economy and society, but the emergence of GC also offers unique opportunity to advance the goal of sustainability, through innovation in chemical product and process design. Sustainability as defined by the Brundtland Commission calls for meeting the needs of the current generation while preserving the ability of future generation to meet their needs. The role of scientists, engineers and policy-makers on all scales is central and essential to determining if and how quickly we move towards a sustainable future. GC, along with the complementary fields of green engineering industrial ecology and sustainability science represents examples of the critical emerging disciplines necessary to realize this goal. GC however, is one of the most fundamental of these fields, in that, it focuses on the molecular level, to design chemical processes and materials to be inherently non hazardous and non-polluting. Given the expansive use of chemicals and chemical products, throughout the economy and society, creating benign feed stocks will have far-reaching effects or consequences by providing engineers, scientists, industrial ecologists with the necessary building blocks in the design of sustainable products, processes and systems. Hence, GC concept and principles are fundamental tools for achieving sustainability.

Barriers to Implementation of GC in Nigeria

While the benefits, accomplishments and prospects of GC have been and continue to be demonstrated across the chemical enterprise, its widespread penetration and implementation has been impeded by its fundamental and disruptive nature. According to Matus, Paul, William, Clark, & Kai (2007), there are six major classes of barriers to the implementation of GC which are;

1. **Chemical enterprise: Complex and intertwined:** The sections of industries that fall under the chemical enterprise umbrella are both large and diverse. They range from pharmaceuticals to textiles, pesticides, paper, petroleum products; specialty chemicals such as perfumes, cosmetics, fertilizers, plastics and just about everything in-between. The variety and ubiquitousness of the use and production of chemical within industry, represents the first barrier. Many firms that fall within or into the chemical umbrella may not see them as such, which makes the dissemination of information to these areas much more difficult. Many of the sectors in the industry are highly intertwined, which means that firms within the chemical enterprise occupy a variety of positions along the supply chain, from primary production all the way to consumer products.

2. **Economic and financial barrier:** Building new chemical infrastructure can be very expensive, and the high cost can be a significant barrier to implementation of green chemical processes. In addition, within the chemical industry, a new product or process based on GC must meet two criteria; economic and environmental performance. The new product and/or process must not only represent an improvement for health, safety and environment, but it must also be more profitable. A small decrease in costs associated with waste, or the use of less hazardous or more efficient process, may not be enough to justify large changes, which can be a significant barrier to GC implementation.
3. **Regulatory Barrier:** The significant growth in environmental regulation over time has had an important impact on the chemical enterprise. Given the increasing globalization of the chemical enterprise, many firms must also cope with. The regulations (which may differ significantly in all of the countries where they produce and sell their products) This means that many firms find themselves in situation where they must spend precious resources on regulatory mandated, and often expensive, instead of investing in research and development to move towards inherently safer products and processes. There are also regulatory barriers that emerge from the particular details of a given set of regulation, such as those that surround certification of product, financial regulations can also create barrier e.g. the accounting system.
4. **Technical Barrier:** The science behind is often complex and multi-disciplinary. There is a huge variety of technical knowledge within the industry, much of it highly contextual and specialized.
The number of disciplines involved in GC also creates a technical barrier. For example, a chemist typically does not have a working knowledge of toxicology or ecology or chemical engineering. Similarly, chemical engineer does not have extensive knowledge of either ecology or toxicology. This lack of a broader technical background in the training of chemists, including the ability to think in a more global systems level, has emerged as an important barrier to the implementation of green chemistry.
5. **Organizational Barrier:** Within a chemical enterprise or firm, the implementation of GC can run into problems, that are the result of the organizational structure. For example, organizational barrier can occur when the 'champions' and advocates of a green product or process are not in the position of power.
6. **Cultural Barriers:** One of the most important cultural barriers is awareness. While GC has made significant progress, it is unknown or misunderstood by a large number of chemists and the general public. Hence, it is not part of the standard curriculum in schools. Some may even harbour misconception

regarding the actual nature of GC. There are also cultural barriers that arise from the differences between the research interests of chemists in the academia and chemists within industry. Academia is concerned with providing an education that produces first-rate chemists and the definition of what that education includes have remained remarkably constant for a long time. Changes in chemical education have been difficult, while efforts of chemists in the industry are concentrated on particular problem which they are attempting to solve, in an arena where speed, effectiveness and cost efficiency are very important to their personal success. In addition, the degree to which the culture of a firm shuns or encourages innovation in general can create a significant barrier to the implementation of GC.

7. **Barriers regarding: Definitions and Metrics:** An important barrier emerge from questions about what exactly constitute GC. The term is often used interchangeably with sustainable chemistry and are often grouped together with green engineering and sustainable development. Is it a branch of chemistry like organic, physical etc. This kind of definitional fuzziness can be very negative and has led to conclusion and argument about whether a given reaction, product or process really represents GC. This impediment is further compounded by the absence of metric or certification for GC. One of the consequences that emerge from the loose definition and current lack of metrics is that it is hard to point to a given product and declare it green.

Overcoming These Barriers and Promoting GC

The challenge of promoting greater adoption of GC research and innovations is substantial. This is because GC is a disruptive emerging technology embedded in a complex scientific, political, regulatory, economic, organizational and cultural framework. Accomplishments in GC are innovations in a large system that spans border between nations, between industries and between scientific disciplines.

- i. **Support by Politics/Government:** To ensure a sustainable and wealthy future, politics must give science especially GC a higher priority. This means government should create incentives for the development and implementations of innovations in GC. This entails more financial funding for GC research and education. Politics, also should not miss the chance to make people part of the solution. In this regard, government should facilitate linkages, networks and collaborations that positively impact the exchange of information, expertise, tools etc. It also requires politics or government to act as a facilitator for multi-stakeholder initiatives to create and enforce GC metrics and standards. Promote actions this makes HSE impaperlcts a larger part of the decision calculus, and support research, knowledge creation and educational efforts toward GC, across a range of disciplines and problem areas.



Father, politics have a heavy responsibility to guide the industry's development towards GC, its guiding principles and rising demand. Hence, a regulatory framework is required, with strict sanctions for non-GC actions by companies. Likewise, chemical firms conducting or implementing GC principles and innovations could benefit from incentives such as tax reductions or rewards that give GC products competitive advantages.

ii. **Support through Science and Education:** To face the challenges of developing GC products and processes, fundamental and applied research, as well as a well-educated and skill workforce with innovative ideas is required. More practical classes and interdisciplinary teaching should thoroughly prepare them for the tasks ahead. There is therefore need for the chemical industry to participate in science education e.g. by sponsored scholarships, training programs or the provision of well-equipped laboratories. There is also need for education in science, especially chemistry, in schools to start much earlier, with modern teaching techniques and use of everyday examples where chemistry improves our lives. This could increase children's interest in chemistry and its impact on individual as well as on other disciplines

According to Pasqualle and Michael (2019), the necessary key competences individuals should have for promoting sustainable development includes systems thinking, strategic normative, anticipatory and inter personal competence. However, these are not sufficiently imparted in adult education in Nigerian. Adult education is still devoid of teaching these proposed sustainability competences. Consequently, education in chemistry needs to be rethought and updated to the needs and aspirations of the twenty first (21st) centuries. This is the most effective way to adopt GC research and industry to these needs. In fact, according to Ritcher and Dobbelaar (2022), GC should be made the norm rather than the novelty.”

In addition, GC education should not be only for schools and universities, but also as a life-long education and learning process for professionals. This includes regular exchange and a cooperative discourse among stakeholders from other disciplines.

It is important to note that, the training of next generation of scientists and engineers in the methodologies, techniques and principles that are central or essential to GC is vital to its success. To this end, professional societies, private industry and educational community should work together to develop comprehensive curriculum, textbooks, case studies, laboratory experiments and training opportunities for students and teachers. Finally, private industry should begin to retrain their current workforce, encouraging GC innovation through in-house award programs, salary bonus incentives and promotions.



Conclusion

From the foregoing, it is obvious that GC aims to develop new practice of chemistry with rules which, not only provides platform for achieving sustainability but also provides resolutions to problems facing humanity today, such as, pollution, climate change, diminishing natural resources among others. Promoting implementation of GC, practice is a fundamental approach in shaping a sustainable economic growth. It not only affects chemical production, but also has impact on industrial and consumer products, including effects on HSE, working conditions as well as economic growth. Promoting implementation and adaption of GC principles, although not without its serious barriers and setbacks requires a collaborative effort of industry, academia, government and other stakeholders. GC would help, when adequately implemented to build a more sustainable, safer, progressive and prosperous mother planet for all humanity.

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Effect of Social Media on Undergraduate Students' Performance and Interest in Physics in Delta State

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Abstract

The study was designed to determine the effect of social media on undergraduate students' performance and interest in Physics in Delta State. Five research questions were formulated for the study. The study adopted descriptive survey research design. The target population of the study comprised of all undergraduate Physics students in Federal College of Education, Asaba. The sample of the study was 30 respondents. Simple random sampling technique was used to obtain the sample. Data collected from respondents were obtained using structured questionnaire and analyzed using mean and standard deviation. The results of the analysis revealed that social media such as Facebook, WhatsApp, amongst others enhanced academic activities of Physics students in Federal College of Education, Asaba. However, addiction to social media than books, being a great source of distraction while studying, difficulties in managing time properly for effective study, and health challenges encountered because of constant use were negative impacts of social media on the Physics students. The study recommended amongst others that Physics students should be educated on how to maximize the potential of the different social network sites for their academic benefits, lecturers should ensure that they use social media as a tool for improving learning and promoting the academic performance of students in the College and that students should create a balance between academic and non-academic activities on social media by focusing mainly on the academic relevance of most sites instead of engaging in unprofitable surfing.

Keywords: Social Media, Physics, Technology, Performance

Introduction

Communication is very essential for transferring and accessing information. The world is now a global village because of modern technology, and social media often functions as the connecting factor. Modern technology is helping people to be better informed by accessing information about anything at anytime and anywhere. Social media exist so as to provide communication among people regardless of the distance, making it easy for people to share information, files, pictures, videos, create blogs, send messages and conduct real time conversations (Boyd, 2008).

According to Wikipedia, social media is often referred to as computer-mediated technologies that allow creating and sharing of ideas, career interest and other forms of expression through virtual networks (<https://en.m.wikipedia.org>). It is a social structure made up of individuals or organizations called nodes which are connected



by one or more specific types of interdependency, such as friendship, kinship, common interest, dislike, knowledge or prestige, relationship, beliefs, financial exchange etc. (Boyd, 2008; Chutter, 2009).

The favorite realm of these media sites are facebook, whatsapp and twitter. These social forums are playing a large and influential role in decision making in global economy, social and educational ventures. Since social media has come to stay as a result of the advancement in technology, its impact on students' performance at all levels of learning has been one of the concerns of academicians (Enriquez, 2010; Fatokun, 2019). With so many social networking sites displayed on the internet, students are tempted to abandon their assignment and reading schedule in preference to chatting online with friends as well as some who are now addicted to the online rave of the moment with facebook, whatsapp, twitter and so on. Undergraduate students are a unique population occupying the middle group between childhood and adulthood. They have been at the fore front of social change since the end of World War II (Ranaweera, 2015). Also, teenagers and university students have embraced social media as a way to connect with their peers, share information, reinvent their personalities and showcase their social lives (Boyd & Ellison, 2007).

Social media use in universities has many advantages, these include enhancing relationship, improving motivation, offering personalized course material and developing collaboration abilities. This means social media have the ability of improving students' participation in class particularly where introverted students are involved. Students can function in online groups learning with less or no anxiety of needing to raise questions before peers at school. A direct relationship exists between social media usage and academic performance of university undergraduate students (Bamigboye & Olusesan, 2017). On the contrary, attention has been shifted from visible to invisible friends, while important ventures like studying, reading printed materials and writing are affected in the process. This phenomenon has become a source of worry to many who believe in knowledge and skill acquisition. Moreover, the darker side within technological evolution has resulted in dilemmas, such as the set back of real life values especially among students who form the majority of users interacting through the use of social networking sites. It is also a common sight to see a youth chatting in sensitive and highly organized places like the church, mosque, and even in lecture venues. Some are carried away that even as they walk along the highway, they keep chatting.

Physics, being the most fundamental science, derives its reputation as a difficult subject primarily from its dominant problem-solving nature. Furthermore, as a subject that deals with physical quantities and mathematical exactitudes, virtually all branches of Physics are concerned with problem-solving. It suggested that social media can help to enhance teaching and learning of physics especially in higher



institutions. However, with all the laudable potentials of social media to university education, there are contrary feelings in some quarters of its negative influence on students' pursuit of academic excellence (Yeboah & Ewur, 2014). Researches show that heavy users of facebook received lower grades compared to the light users. In a study conducted by Adamu (2011), on impact of third screen, that is, the GSM handset on academic performance of Ahmadu Bello University students. It was found that most students use their social media through GSM handset during lectures. Jegede (2015), noted that youths cannot go for 2-3 hours without checking and updating their profiles on social media even at the detriment of other activities such as education or career pursuit. It is against this background the study seeks to address effect of social media on undergraduate student's performance and interest in physics.

Impact of Social Media on Student Academic Life

Social media provides students a new mechanism for a familiar exercise. It provides students a direct medium by which to publicly evaluate and comment on their campus environments, institutional policies, classes, professors, and administration and fellow students in real-time. Social media zips through our campuses nearly unseen, dragging behind it the heavy weight of social injustices and complicated Jurisprudence accumulated from decades of student speech. Given social media's potential for positive impact, no one is suggesting we pull the breaks on it, and in many ways the technology is already out of our grasp. Also, students use social media to communicate with their Teachers as a group outside of class and to plan school events and what not, it also allowed students to get help on school work from teachers during the evening, weekends, and holidays so that they never fell behind. The cell phone numbers and WeChat are equally used to get in touch with teachers quickly during the school day, if a student is going to be late or absent or outside of school in an emergency. On the subject of the number of complaints of inappropriate contact involving social media, the possible threats are too great.

Users could easily display, send, retrieve, or download any items that are sexually explicit, or contain hate based or discriminatory material without the notification of a teacher, school administrator or even their peers in the event. This in turn could make students concede that they have no right or expectation of privacy with respect to their use of school technology, therefore would not wants to participate fully.

Features of Social Media that Enhance the Interest of Students

Social media websites contain an abundance of different information with millions of links to other resources. This means that apart from games and music, students can find answers to important questions from social media. These sites can be useful in preparing for the lessons as you can find some interesting data there or get help from others if there are any difficulties (Siemens & Weller, 2011). Another great feature of

social networks is an opportunity to learn about education. Many students desire to study abroad and look for opportunities to fulfill their dreams. The following sites offer much useful information on students programs and grants as well as you can ask other students from different countries about cost of living or studying personally. Different educational technologies, as well as Learning Management System (LMS) introduction, has made significant changes in education. They have become a great motivation for students to achieve better results. Modern teachers realize that social media plays a very important role in students' lives so the combination of these social networks with LMS can be a perfect solution (Sokoya, Onifade & Alabi, 2012). For example, it is much more interesting to discuss a topic in the social media chat than those that are in the customary classroom (Sokoya, Onifade & Alabi, 2012). It both makes students think or respond to other statements and improve their spelling.

One more positive side of using social networks in education is a desire to read and write without any obligations (Habes, Alighizzawi, Khalaf & Sudoum, 2018). Usually, kids and teenagers do not like reading or writing text and parents have to force them to do that killing any desire to study. Messages, news, comments, articles-the list of information on the website pages can be endless and students are ready to devote time and learn all that without putting efforts (Habes, Alighizzawi, Khalaf & Sudoum, 2018). That contributes to the overall level of intelligence as well as improves writing and reading skills.

Statement of the Problem

Since the initiation of social media sites in the 1990s, it is understood that in many parts of the world the academic performance of students is facing a lot of neglect and challenges. The researcher observed that students studying physics in degree programme in Federal College of Education (Technical), Asaba have a divergence, interruption and alienated attention between social networking activities and their academic work. It is pragmatic that students dedicate more attention to social media than they do to their studies Enriquez (2010), equally revealed that students who multitask between social networking and homework are likely to have 20% lower grades than those who do not have a social networking site on the background of their personal computer while studying or doing homework.

Purpose of the Study

The study was designed to:

1. Find out how Physics students use facebook, whatsapp, and twitter for academic purposes?
2. Find out which of the social media is frequently used among the three mentioned above by Physics students
3. Determine the positive influences of social media on academic performance of Physics students
4. Ascertain the features of social media that enhance the interest of Physics students

5. Ascertain the negative effects of students' engagement in social media on their academic performance

Research Questions

The following research questions are formulated to guide the study:

1. How do physics students use facebook, whatsapp and twitter for academic purposes?
2. Which of the social media is frequently used among the three mentioned above by Physics students?
3. What are the positive influences of social media on academic Performance of Physics students?
4. What are the features of social media that enhance the interest of Physics students?
5. What are the negative effects of students' engagement in social media on their academic Performance?

Research Methodology

The research study adopts a descriptive survey design. The descriptive survey design, despite being used for both exploratory and preliminary studies allows the researcher to gather information, summarize, and interpret the information for the purpose of clarification. The population of the study comprised all the 100, 200, 300 and 400 levels undergraduate physics students of Federal College of Education (Technical) Asaba. Forty (40) students from all the levels (100-400 level) undergraduate physics students of Federal College of Education (Tech), Asaba were randomly sampled from the study population. Structured questionnaire titled: Effect of social media on undergraduate student's academic performance and interest in physics “(ESMUSAPIP)” was used for data collection in this study. The questionnaire was divided into Part A and B.

Part A elicited demographic information of students. Part B was divided into 5 sections (Section A to E). Section A elicited how physics students use facebook, whatsapp, and twitter for academic purposes; Section B elicited which of the social media is frequently used among the three mentioned above by physics students; Section C elicited the positive influences of social media on academic performance of physics students; Section D elicited features of social media that enhance the interest of physics students; and Section E elicited negative effects of students' engagement in social media on their academic performance. Four scale responses were used as follows: Strongly agree (4); Agree (3); Disagree (2); Strongly disagree (1). The instrument was validated with the help of two experts from Department of Science Education, Delta State University, Abraka. The reliability of the instrument was carried out by selecting 10 teachers outside the study population. Cronbach alpha method was used to determine the reliability of the instrument. A coefficient of 0.76 was obtained which indicates a high reliability for use.

Results

The results obtained from the analysis of data are presented below.

Research Question 1

How do physics students use facebook, whatsapp, and twitter for academic purpose?

Table 1: Mean responses of respondents on how physics students use facebook, whatsapp, and twitter for academic purpose (N=30)

S/N	Statement Items	Mean	SD	Remark
1.	Sharing information with fellow students	3.73	0.62	Agree
2.	Solving my assignment/academic problems	3.59	0.74	Agree
3.	An effective tool for knowledge creation and dissemination	3.43	0.77	Agree
4.	Using it to engage in group discussion on any of the social network sites	3.68	0.68	Agree
5.	Distributing past examination material	3.78	0.81	Agree
6.	Submitting assignments to course lecturers or collecting course materials	2.91	0.86	Agree

Source: Field Work, 2021

The result in Table 1 shows that statement items had a mean range of 2.91 to 3.78. The mean scores were above the cut-off points of 2.50. The respondent agreed that the identified items were *how physics students use facebook, whatsapp, and twitter for academic purpose*. The standard deviation of the items ranged from 0.62 to 0.86. This indicated that respondents were unanimous in their responses.

Research Question 2

Which of the social media is frequently used among Physics students?

Table 2: Mean responses of the respondents on social media is frequently used among physics students (N= 30)

S/N	Social Media	Mean	SD	Remark
1.	Facebook	3.51	0.63	Always
2.	Twitter	2.31	0.71	Rarely
3.	Instagram	2.06	0.74	Rarely
4.	WhatsApp	3.71	0.78	Always
5.	Telegram	3.61	0.68	Always
6.	Badoo	1.03	0.54	Rarely

Source: Field Work, 2021

The result in Table 2 shows that the respondents agreed that facebook, whatsapp and telegram were social media that they always use. The statement items had a mean range of 1.03 to 3.71. Mean score of item 2, 3 and 6 were below the cut-off points of 2.50 while item 1, 4 and 5 were above the cut-off point. The standard deviation of the items ranged from 0.54 to 0.78. This indicated that respondents were unanimous in their responses

Research Question 3

What are the positive influences of social media on academic performance of Physics students?

Table 3: Mean responses of respondents on positive influences of social media on academic performance of physics students (N= 30)

S/N	Statement items	Mean	SD	Remark
1.	It enhances understanding, better assimilation and higher retention of difficult concepts learnt in physics	3.73	0.62	Agree
2.	It is used to obtain information about assignment given to us when I am out of school premises.	3.59	0.74	Agree
3.	Social media aided or improved my overall academic performance in physics courses	3.43	0.77	Agree
4.	My interest in physics improve through exploration of social media for learning	2.68	0.68	Agree
5.	My consistent use of social media to boost my knowledge of physics has led to increase in my GPA over time	3.78	0.81	Agree
6.	It has exposed me to the latest information in physics	2.56	0.78	Agree
7.	It helps students to engage in group discussion on difficult aspects of our course	2.76	0.68	Agree

Source: Field Work, 2021

The result in Table 3 shows that statement items had a mean range of 2.56 to 3.78. Most of the means were above the cut-off points of 2.50 while Item 4 (1.68) was below the cutoff point. The agreed items indicated positive influences of social media on academic performance of physics students. The standard deviation of the items ranged from 0.62 to 0.81. This indicated that respondents were unanimous in their responses.

Research Question 4

What are the features of social media that enhance the interest of Physics students?

Table 4: Mean responses of the respondents on features of social media that enhance the interest of physics students (N= 30)

S/N	Statement items	Mean	SD	Remark
1.	Social media websites contain an abundance of different information in physics	2.51	0.63	Agree
2.	They have feature that help to correct spellings	2.71	0.72	Agree
3.	It provides room for private chat with teacher or fellow student	3.06	0.74	Agree
4.	It contains music, videos that entertains	3.21	0.78	Agree
5.	It provides room to demonstrate teaching even from the comfort of your room	3.61	0.68	Agree
6.	It can be used to create polls and quizzes	1.22	0.66	Disagree

Source: Field Work, 2021

The result in Table 4 shows that the respondents agreed that the identified statement items are features of social media that enhance the interest of physics students. The statement items had a mean range of 1.22 to 3.61. Most of the means were above the cut-off points of 2.50 while item 6 was below the bench mark. The standard deviation of the items ranged from 0.63 to 0.78. This indicated that respondents were unanimous in their responses.

Research Question 5

What are the negative effects of students' engagement in social media on their academic achievement?

Table 5: Mean responses of respondents on negative effects of students' engagement in social media on their academic performance (N= 30)

S/N	Statement items	Mean	SD	Remark
1.	Students can be addicted to social media than my books	2.53	0.62	Agree
2.	Social network sites can be a great source of distraction while studying	3.09	0.64	Agree
3.	Students have difficulties in managing time properly for effective study because of my engagement with social media	3.03	0.77	Agree
4.	Course grade score might not improve as expected despite adoption of social media to enhance performance	1.68	0.68	Disagree
5.	Some health challenges can be encountered because of constant use of social media	2.78	0.81	Agree

Source: Field Work, 2021

The result in Table 5 shows that statement items had a mean range of 1.68 to 3.09. Most of the means were above the cut-off points of 2.50 while Item 4 (1.68) was below the cut-off point. The agree items are negative *effects of students' engagement in social media on their academic achievement*. The standard deviation of the items ranged from 0.62 to 0.81. This indicated that respondents were unanimous in their responses.

Discussion of Results

Physics students use facebook, whatsapp, and twitter for academic purpose

The result in Table 1 showed that sharing information with fellow students, solving assignment/academic problems, effective tool for knowledge creation and dissemination, submitting assignments to course lecturers or collecting course materials, amongst others were ways the students use facebook, whatsapp, and twitter for academic purpose. Consequently, the high take up of social media applications as an addition to formal educational settings offers new opportunities for innovating and modernizing education institutions and for preparing learners for the 21st century.

Social media frequently used by undergraduate physics students in Federal College of Education (Technical), Asaba

The result in Table 2 showed that physics students in Federal College of Education (Technical), Asaba agreed that facebook, Whatsapp and telegram were social media mostly used for their academic activities. In confirmation with result, researchers have applauded the usefulness of WhatsApp in academics, especially as it helps in fostering knowledge sharing, enhancing peer support on educational affairs and nurturing knowledge communities.

Positive influences of social media on academic performance of physics students

The result in Table 3 showed that social media have positive influence on Physics students by enhancing their understanding, better assimilation and higher retention of difficult concepts learnt in Physics, obtaining information about assignment given, improve overall academic performance in Physics courses, boost knowledge in Physics and as such GPA, among others. This implies that social media had academic usefulness to students as it improved their performance in Physics courses. This is consistent with the view of Bamigboye and Olusesan (2017), who attested that students are positively affected by the informative use of the social media.

Features of social media that enhance the interest of physics students

The result in Table 4 indicated social media had features that enhanced interest of Physics students such as containing an abundance of different information in Physics, feature that help to correct spellings, provides room for private chat with teacher or fellow student, provides room to demonstrate teaching even from the comfort of one's room, amongst others. This implies Physics students in Federal College of Education (Technical), Asaba agreed that social media improved their interest in physics especially with its convenient features.

Negative effects of students' engagement in social media on their academic performance

The result in Table 5 indicated that some negative effects of students' engagement in social media such as: students being addicted to social media than books, being a great source of distraction while studying, difficulties in managing time properly for effective study, and health challenges encountered because of constant use. This implied that social media can have a negative influence on student's performance in Physics. In line with the finding, Adamu (2011), explored the impact of third screen, that is, the GSM handset on academic performance of Ahmadu Bello University students, it was found that most students use their social media through GSM handset during lectures.

Conclusion

Conclusively, social media contains applications that support enthusiasm in a common space around sharing interests, collaborations, resource sharing,

communications and interactions. The study indicated that social media like facebook, whatsapp, among others enhanced academic activities of physics students in Federal College of Education, Asaba. facebook, Whatsapp and telegram were social media mostly used for their academic activities, social media had academic usefulness to students as it improved their performance in physics courses. The students agreed that social media improved their interest in physics especially with its convenient features. However, Addiction to social media than books, being a great source of distraction while studying, difficulties in managing time properly for effective study, and health challenges encountered because of constant use were negative impacts of social media on the physics students.

Recommendation

The researchers made the following recommendations based on the findings;

1. Physics students should be educated by their educational institutions, faculties, academic advisors and peer mentors on how to maximize the potential of the different social network sites for their academic benefits.
2. Lecturers should ensure that they use social media as a tool for improving learning and promoting the academic performance of students in the College.
3. Students should create a balance between academic and non-academic activities on social media by focusing mainly on the academic relevance of most sites instead of engaging in unprofitable surfing.

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Modern Methods for Improving Teaching and Instructions in Science Subjects in Secondary Schools, Nigeria

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Abstract

Efforts have been made to improve science teaching and learning in Nigeria schools, yet students continue to perform below average in science subjects. Many modern teaching methods have been developed by educators and found to impact significantly on students' academic achievement when utilized. Hence, this paper discussed the ways which science teachers can improve teaching and instruction using modern approaches in secondary schools. Science teaching like every other area of discipline has a systematic way of planning its activities and implementing same within a specified time period. For teaching learning process to be successful, the teacher must ensure to make use of appropriate teaching methods to drive of home the instruction into the learners and also to be able to get desired objectives achieved. The paper also proffer recommendations, one of the suggested recommendations amongst others is that school authority should encourage their teachers to use modern teaching methods and also provide them with materials and fund to achieve this feat.

Keywords: Science, Education, Teaching Methods, Classroom

Introduction

Education is a process by which the personality of a child is developed. Thus, the education should be able to play its role more effectively by making the individual creative, innovative and effective. Science is one of the fields of study in education. Sciences in secondary school comprise of Biology, Physics, Chemistry and Agricultural science, Basic Technology and others. Science as a field of study has made it possible for man to know more about the universe. The effective teaching of science subjects can lead to the attainment of scientific and technological greatness (Adesoji & Olatunbosun, 2008.) Science teachers are crucial in translation of science educational objectives into practice. Science education provides a more effective preparation for students to translate acquired knowledge in science to technology and in order to achieve this teacher need to adopt modern strategies to impact knowledge during the process of teaching- learning.

The persistent poor performance in science subjects at School Certificate level has given rise to an assumption that most science teachers in secondary schools in Nigeria probably do not make use of varied forms of teaching methods to be able to cope with some specified difficulties associated with the teaching and learning of science by both teachers and students respectively (Achor, 2003; Umoren & Ogong,



2007). Nwosu (2004), submitted that most science teachers do not possess the prerequisite knowledge needed for activity - based learning and as a result, the most prevalent method of teaching has been talk and chalk (lecture) method. Ajaja (2013) identified the method adopted for teaching and learning science as one of the factors contributing to this low interest in science and hence expressed the need for a search for alternative instructional strategies that could stimulate students' interest and enhance their academic achievement. The use of various teaching methods is borne out of the fact that there are different topics to be taught and skills intended to be developed. Many innovative methods of teaching have been developed by educators with a view to involving learners more in the teaching- learning process. This is considered very important and there is the need to get these strategies into the classrooms, for this to be done successfully there is need for teachers not only to be aware of these strategies but also to learn how to use these strategies appropriately in the classroom.

What is Modern Teaching?

Teaching methods also called teaching strategy or instructional strategy has variously been defined by several authors. Some of the definitions include that of Kizlik, (2016), who defined teaching methods as process that are primarily descriptions of the learning objective- oriented activities and flow of information between teachers and students. The teaching method which focuses more on teaching the students for improving their intellect behavior by using various new and innovative ideas rather than making them recite the syllabus to clear the examination with the same old style is Modern Teaching Methods in simple words. Modern teaching focuses on the entire learning process, rather than focusing strictly on the final result, and is dedicated to helping students build skills as part of a constructivist approach to learning.

The new teaching method which we called the modern teaching method is more activity- based and centre's the learner's mind which involves them entirely into the process of learning. In the modern teaching method, curriculum teaching and planning are done keeping the learner as the primary target. Through this way, learners actively participate in the whole and process to build their knowledge and sharpen their skills; this is also termed as a constructivist approach. Modern teaching methods are necessary because they help meet the educational needs of students in the contemporary era. It also focuses specifically on expanding their fundamental knowledge about the world and building critical thinking skills that will allow them to handle all kind of challenges as they advance in their academic careers. Teachers need to be conscious of the fact that this is an entirely different angle of teaching and learning because modern teaching methods do not treat all students at the same level of their understanding ability, unlike the conventional method of teaching. Rather than the teacher based, modern teaching moderns focus more on questioning,

demonstration, explaining, practical, collaboration methods, and are more activity-based.

Modern teaching methods forms a part of a mass educational reform, brought on by the advent of technology and the need to not only educate but also inspire and generate curiosity. This has resulted in the need to modify the traditional style of teaching methods in such a manner that the new teaching methods are demonstrative, explanatory and practical. Recent empirical studies have indicated that some of these innovative teaching methods produced results in terms of students' learning. For instance, Lamidi, Oyelekan and Olorundare (2015) conducted a study to determine the effects of mastery learning instructional strategy on secondary school students' achievement in mole concept, a topic that has been empirically identified as difficult to understand by students. It was found out that students taught using the mastery learning instructional strategy performed significantly better than their counterparts in the control group. Similarly, Gambari, Yusuf and Thomas (2015) examined the effectiveness of computer-assisted instruction on Student Team Achievement Division (STAD) and Learning Together Model (LTM) cooperative learning strategies on Nigeria secondary schools students' achievement and motivation in Physics. They found out that the students taught with STAD and LTM performed significantly better than their counterparts taught using individualized computer instruction (ICI). It was further indicated that their cooperative learning strategies were found to be gender friendly. These new teaching techniques involve a style of teaching that focuses on cognitive thinking and the development of new patterns of learning. In modern education methods, the student is central to curriculum designing and lesson planning. The teacher acts as a facilitator, paving the way for the necessary resources and support.

Characteristics of Modern Teaching Methods

Modern teaching methods features several unique characteristics dedicated to helping support the growth of students' intellectual capabilities and skills. Some of these primary characteristics include:

1. **Learner-centered:** modern teaching methods are designed to focus on learners and keep them from being treated as denominators in classroom interactions, especially within the realm of Basic Science and Technology curriculum.
2. **Activity- based:** modern teaching methods instruct students through activities and specialized tasks to broaden their education.
3. **Resources- Based:** teachers utilizing modern teaching methods are often dedicated to nurturing the resourcefulness of their students by encouraging the use of different, helpful project materials.
4. **Interactive in Nature:** one of the most vital characteristics of modern teaching methods is that tasks, projects and problems are often interactive.



5. **Peer Collaboration:** modern teaching methods do not just encourage students to learn from educators but also from their peers. Peer collaboration ensures students receive all of the attention and feedback they need.

Modern Teaching Methods

Modern teaching unquestionably is the need of the hour because of its relevance in the modern era. The revolution in the field of science and technology demands great ideas and extensive effort to deal with any kind of circumstances coming in the way of development. All the load is on the little shoulders of learners not only knowledge but to improve their skills from the very beginning.

The following are the modern teaching methods that educators have forged over the last few years and every teacher should be acquainted with most especially in teaching science subjects in secondary schools:

Asynchronous Learning Method: Asynchronous learning used to be a term that was rarely mentioned by anyone other than professionals in the fields of education, corporate learning and development, and instructional design. However, widespread changes to teaching and learning over the last few years have ushered asynchronous learning into the spotlight. Asynchronous learning describes educational activities, discussions, and assignments that engage students in learning at their own pace, on their own time. Asynchronous learning is a general term used to describe forms of education, instruction, and learning that do not occur in the same place or at the same time. It can also refer to delivering course material in a way that is not bound to a particular time. The students don't have to be in the same brick- and mortar classroom nor the same online learning space at the same time to study. There can be no instructor in touch.

Moreover, course content and assessments delivered asynchronously leaves it up to the students when they participate in your class. Students who have other responsibilities or less frequent access to technology will benefit from asynchronous teaching. The flexibility of the time frames, however, does not mean going loose and falling off in the discipline. Asynchronous learning may have strict deadlines. Providing the freedom to choose the approach to learning and time for it, asynchronous learning often demands the result (completed course, score, status, etc.) before a certain date. Facilitators of asynchronous training don't control their learners' but they usually watch the deadlines closely.

Examples of asynchronous learning:

- Watching pre-recorded lecture videos or lessons
- Viewing video demonstrations
- Reading and writing assignments
- Research projects
- Student presentations
- Online class discussions via course discussion boards

- Individual or group projects
- Learning activities such as quizzes, problem solving and games.

Asynchronous learning offers a decisively effective learning that enables students to benefit from the following:

- Never miss a class
- Learn at any pace
- Personalize and optimize the learning experience
- Revisit lessons as needed to improve comprehension and retention
- Take advantage of extra time to process, practice, and respond
- Adapt learning to self- accommodate for disability

Synchronous Method of Learning: Synchronous learning is a fantastic way of encouraging discussion and engagement among students. It is a learning event in which a group of students are engaging in learning at the same time. It can happen either online or offline; in both cases, it is highly time- related. It refers to a learning situation whereby instructors and students gathering at the same time (virtual or physical) and place and in real time. It is a method of course delivery that refers to delivering course materials to students at a particular time, all together. Course content and assessment delivered synchronously require students to participate in your class at a particular set time or window of time. Examples are commonly to refer to synchronous video session such as zoom lectures, standard in- classroom class sessions are also synchronous. Students who are unable to attend at the designated time may benefit from special accommodations such as recording live sessions for participate.

Benefits of Synchronous Learning

1. It provides a better feedback: being present here and now enhances feedback on learners. This allows them to correct mistakes right on the spot and get positive reinforcement of the desired behavior, performance, or using a new skill. Plus, this channel works two ways, so an instructor can also get feedback from the learners and adapt the presentation or provide additional information if there are questions.
2. Collaboration, Engagement, And Interactivity: the best part of learning with a teacher and your peers in real- time is learning and working together. Learning together gives learners the ability to engage with the content, the teacher, and each other in ways that asynchronous e- learning cannot match.
3. It improves learner outcomes
4. It reduces cost.

Computer Supported Collaborative Learning (CSCL): Computer supported collaborative learning is considered as one of the most promising innovations to improve teaching and learning with the help of modern information and

communication technology. According to Johnson, Johnson and Stanne (2000), Computer Supported Collaborative Learning (CSCL) refers to learning situations mediated by technologies where small groups of 3 to 5 students are exposed to interaction in order to solve a complex unstructured problem or are required to design a project. Furthermore, Computer Supported Collaborative Learning is an innovative educational tool that brings the learners together and can offer creative activities of intellectual through taking advantages of exciting potential of internet resources for significant transformation of learning.

Computer Supported Collaborative Learning is focused on how collaborative learning supported by technology facilitates sharing and distributing of knowledge and expertise among community members. Hence, learning through collaboration means learning through interaction. Research in CSCL has established following different interaction models

- Teacher- student interaction and intra- group emotional support;
- Student interaction in work groups and collaborative learning;
- Online collaborative tools and students' interaction in their work groups.

Cooperative Learning: This is a methodology that teachers use to group students together and thus, impact on learning in a positive way. The proponents of this model theorize that working in a group improves the attention, involvement and acquisition of knowledge by students. The final goal is always group-oriented and will be achieved if each of the members successfully performs their tasks.

The main characteristic is that it is structured based on the formation of groups of 3-6 people, where each member has a specific role and to reach the objectives it is necessary to interact and work in a coordinated manner.

Gamification: Gamification is the process of transforming typical academic components into gaming themes. Gamification endeavors to literally create a game out of learning by theming all components of your classroom in a game metaphor, making your class like one big first person game. The goal of this method is to enhance learning by increasing student's engagement. The most important indicator of a student's knowledge attainment is engagement, the level of attention and personal involvement a person has with an activity. The more engaged your students are with the learning process, the more they will internalize the learned skill. When it comes to games in education, there are two overall forms it can take:

1. Games designed for entertainment being used in an educational setting.
2. Educators adopting features of game design to enhance learning

Blended Learning Method / Hybrid Learning

Blended learning is an approach of education in which traditional classes are supplemented or supported with technology and learners take advantage both of

online and offline. Blended learning actually encompasses multiple pedagogies and learning methods. Blended learning does aim to replace the teachers with technologies. Instead, the teachers take advantage of technologies to support their lessons and better focus on individual needs of the students. It brings a whole new set of possibilities in terms of flexibility and accessibility, placing the learner at the center of its learning process. Learning relies on broad array technologies. This could include computers, interactive Whiteboards, LMS (Learning Management Systems), videoconferencing, cloud-based solutions, or full online-curricula.

Types of Blended Learning Models

There are five most common types of blended learning frameworks:

1. Flipped Model
2. Face-to- Face Drive Model
3. Rotational Model
4. Flex Model
5. Enriched Virtual Model

Benefits of Blended Learning

1. Learners get a personal experience: it offers a personalized experience. That's because they learn at home in their own time until they understand the topics. By using quizzes and tests online, trainers can see who is struggling and who is performing well.
2. It increases engagement: Blended learning takes advantages of various types of learning materials: info graphics, pictures, videos, tables, graphs, and more. This makes it easier for us to focus, absorb and internalize the information we learn more easily.
3. It increases experiences: one of the greatest blended learning benefits is that it makes learning fun. That's because it combines traditional learning and interactive material.
4. It helps teachers to reply and do assessment fast
5. Learners can access content anytime, anywhere
6. It's easier for teachers to see how learners are doing.
7. It might help students that are slower learners or learn more quickly. But not for drawback students need the social interaction that can't occur via computer.

Advantages of Modern Teaching Methods

Modern teaching methods provide students a wide range of advantages when utilized correctly by eager teachers. Some of the most important advantages that these methods can provide include:

1. Increase cognitive thinking skills
2. Help students develop their prefrontal cortex
3. Emphasize personal development



4. Provide application based skill building
5. Empower students to engage with challenging concepts
6. Allow students to revise and review older concepts.

Conclusion

Modern methods of teaching are methods that when any of them is adopted to be used by teacher for instruction either online or offline it is expected of it to yield result. They are methods that combine use of technology sometime with traditional method of teaching in the classroom. Modern methods of teaching also encourage learner to participate in learning irrespective of their location. They are methods that enhance students' cognitive, affective and psychomotor skills. Teachers also benefit from using these innovative approaches to teach.

Recommendations

1. Science teachers should avail themselves the opportunities provided by these innovative methods of teaching in improving the academic achievement of their students
2. Teacher training institutions in the state should ensure that teachers in training are taught on how to use various modern methods of teaching during course of study.
3. The Nigeria Educational Research and Development Council (NERDC) should consider including more innovative teaching methods to be part of prescribed strategies of teaching in the Senior Secondary Education Curriculum during the review of the present senior secondary school curriculum.
4. Schools authority should encourage teachers on the use of modern teaching methods by providing adequate funds, materials and good learning environment that can facilitate the use of these innovative methods.

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Impact of Teachers' Qualification on Students' Academic Achievement In Basic Science In Oshimili South Local Government Area of Delta State: A Pathway to Sustainability and National Development.

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Abstract

The study investigates the impact of teachers' qualification on students' academic achievement in basic science in Oshimili South Local Government Area of Delta State: a pathway to sustainability & national development. Three research questions guided the study. The study adopted a descriptive survey research design. The population of the study comprised of 42 teachers in 7 selected secondary schools in Oshimili South Local Government Area of Delta State. The sample of the study comprised 42 teachers across the 7 secondary schools. The instrument for data collection was a structured questionnaire titled Impact of Teachers' Qualifications on Students' Academic Achievement in Basic Science Questionnaire (ITQSABSQ). The instrument was validated by the Experts. The reliability coefficient of the instrument was 0.8 obtained using split-half methods. The data collected were analyzed using mean statistics. The findings revealed that impact of teachers' qualification on students' academic achievement in basic science influences students' academic achievement in Basic Science, teachers' year of teaching experience affects students' academic achievement in Basic Science and teachers' knowledge of subject matter has a great influence on students' academic achievement in Basic Science. Based on the findings, the study recommends among others that Teachers should be exposed to seminars and workshop to upgrade and enhance their knowledge in subject matter of Basic Science, Government should only engage qualified teachers to teach students in school, and Educational administrators should organize seminars and workshops to update secondary school teachers on the need for qualification and experience in teaching. Furthermore, Government should ensure that teachers with at least BSc. Ed in Basic Science are recruited to teach Basic Science at secondary school classes to gain experience with time.

Keywords: Impact, Teachers, Academic achievement, Qualifications

Introduction

Education is perhaps the largest and most costly of all the National undertakings in Nigeria nowadays. This is not surprising, since there is a general agreement that education is the most valuable resource in any nation and that it is the foundation of a nation's economic, social and political strength. Education is the cornerstone of any



nation and has remained for some time a big industry in Nigeria (Taiwo, 2018). In recent years, there has been growing awareness that advancement in education depends largely on the qualifications and ability of teachers (Adeogun, 2011). Teachers are the most important single factor in the success of an educational enterprise (Aaronson, Barrow & Sander, 2017).

Teachers, therefore, have a vital role to play in the development of a nation, especially in the upbringing of leaders and intellectuals of tomorrow who will sustain the nation's development (Taiwo, 2018). If one seeks the explanation of the rise of any nation, one will have to turn to schools and examine the calibre of their teachers. Therefore, it is not surprising that both the developed and the developing nations of the world are today asking questions about their teachers, their relevance and adequacy of their preparations. There has been much concern expressed in recent years about the apparent fall in standard of education in Nigeria, most especially at the secondary school level (Olagoke, 2018). This perhaps explains why Nigerian Government has moved from one system of educational structure to another in search of excellence in its educational products (Duze, 2011). The main causes for this fall in standard of education, according to Olagoke (2018), are low teacher/pupils ratio caused by the geometric progression in students' population and lack of qualified teachers. This downward trend in Nigerian standard of education has become a thorn in the flesh for all science educators who sincerely want to see teachers as transforming elements and students as totally developed individuals capable of affecting technological change in society.

Education and Sustainable National Development: The Relationship.

In all nations, Nigeria inclusive, education remains the instrument for effective national development. Development is championed through education, which is often assumed to have significant influence. Education entails the enlightenment of people in their ways of pursuit in life. Development is associated with a positive change in the condition of either individual groups, communities or even a country as a whole Bwala and Koroma (2011). Education and sustainable national development are interwoven, intertwined, and interconnected. While on the one hand, development is geared towards producing or creating something new or more advanced for the society and its members. On the other hand, education is a tool which can enhance the desired sustainable development. Bwala and Koroma, (2011) therefore, refers education and sustainable development as two sides of the same coin. The fact that education and sustainable development shows glaring connectivity probably explained why scholars emphasized the need for education for the purpose of achieving the desired sustainable development.

Olubadewo (2012), sees education as a systematic procedure for the transfer and transformation of culture through formal and informal training of people in the society. He stated that education deals with mental, physical, psychological and

social development of the citizens in a given society. For any country therefore, to attain sustainable national development, he concluded that “there is need for skilled man power and those skills required are basic ingredients for national development and can only be acquired through education” Olubadewo (2012). From the above, education seems to directly determine whether sustainable national development is going to be achieved or not and therefore, the need for a well-structured educational system that will enhance the achievement of the aforementioned development.

Omiko (2015) defined Basic Science as a science in undifferentiated form which stresses the fundamental unity of science. Basic science involves the study of elementary biology, anatomy, earth/solar system, ecology, genetics, chemistry and physics as a single science subject in the Junior Secondary school. It offers the basic training in scientific skills required for human survival, sustainable development and societal transformation. Basic science studies also involve bringing together traditionally separate science subjects so that students grasp a more authentic understanding of science. The first form of science a Nigerian child encounters in school is integrated science, at the junior secondary school level. This first form of science has changed to basic science due to educational reforms in Nigeria (Federal Republic of Nigeria, FRN, 2017). The subject was introduced into the Nigerian secondary schools as a panacea for some of the problems bedeviling science especially at the junior level, most especially with the revised policy on education with emphasis on the acquisition of process skills (Bamidele and Adekola, 2017). The emphasis of the programme is on the development of the spirit of enquiry as opposed to rote learning, as well as the development of science process skills and scientific attitudes rather than accepting scientific facts as a dogma (Bamidele, 2014).

According to the National Policy on Education (FGN, 2017), basic science is supposed to be presented in such a way that the child:

- i. Gains the concept of fundamental unity of science (Physics, Chemistry and Biology);
- ii. Gains the communality of approach to problem-solving of scientific nature;
- iii. Gains an understanding of the role and function of science in everyday life and the world in which he/she lives.

From the above, basic science serves as the gateway to the study of single science subjects, which provides a solid foundation for the learning of the specialized scientific discipline like physics, chemistry and biology. Hence, a child who is not well-grounded in basic science at the junior secondary school level may see the core science subjects as bitter pills to swallow. Academically, qualified teachers refer to those who have academic training as a result of enrolment into educational institution and obtained qualifications such as HND, B.Sc, B.A, and M.A. and so on;



while professionally qualified teachers are those who got professional training that gave them professional knowledge, skills, techniques, aptitudes as different from general education (Akpo, 2012). They hold degrees like, B.Ed., B.Sc. Ed, B.A. Ed, and M.ed and so on. Darling-Hammond (2011) states that the characteristics of teacher's qualification are verbal ability, subject-matter language, knowledge of teaching and learning the ability to use a wide range of teaching strategies adapted to studies.

A teacher's qualities include preparation and training, the use of a particular instructional approach and experience in teaching. This insight was shared by Mullis, Kennedy, Martin and Sainsbury, (2014) who indicated that teacher's qualification is an important determinant of pupils' performance. The quality of education hinges in the quality of teaching that goes on in the classroom reinforcing the idea that quality teachers make up for the differences in the curriculum and in educational resources (Anderson, 2011). Nwagbo (2013), suggest that even with the shortcomings of current teacher education and licensing, fully prepared and certified teachers are more successful with students than teachers without this preparation. Ashton (2016), also notes that teachers with regular state certification receive higher supervisor ratings and student achievement than teachers who do not meet the above standards.

Teacher experience has a significant effect on pupil achievement in primary schools and at upper secondary level. Experienced teachers have a richer background of experience to draw from and can contribute insight and ideas to the course of teaching and learning, are open to correction and are less dictatorial in classroom. Teachers' experience and student achievement showed that students taught by more experienced teachers achieve at a higher level than those taught by inexperienced teachers because their teachers have mastered the content and acquired classroom management skills to deal with different types of classroom problems Buck, Bretz and Towns (2018). Furthermore, more experienced teachers are considered to be more able to concentrate on the most appropriate way to teach particular topics to students who differ in their abilities, prior knowledge and backgrounds, Selvi (2012). Subject matter knowledge is another variable that one might think could be related to teacher effectiveness. Igwe (2015) concluded that, in basic science, there seems to be a trend that the students whose teachers have basic science education degrees demonstrate higher levels of achievement than teachers without requisite degrees.

Teacher's qualification is widely thought of as an essential determinant of academic performance, yet there is little agreement as to what specific characteristics make a good teacher (Hanushels and Rivkin, 2016). Wambugu and Changeiywo, (2018), states that teaching methods are crucial factors that affect the academic achievement of students, and no matter how well-developed and comprehensive a curriculum is,

its success is dependent on the quality of the teachers implementing it. However, this study will assess the impact of teachers' qualification on students' academic achievement in Basic science in Oshimili South Local Government Area of Delta State.

Statement of the Problem

It is surprising that despite the efforts of Delta State government, to improve the standard of education by providing the required human and material resources for the implementation of education at all levels, students' performance in basic science in internal and external examination is very poor in recent years. This situation makes one to wonder what could be the causes of this persistent failure of students in basic science examination. Some scholars attributed this high failure rate in science and basic science to various factors which could be institutional and non-institutional. Over the years, students' achievement in basic science has prompted educational researchers to continuously make relentless efforts at identifying mitigating factors that might account for observed poor performance. However a lot of variables may inhibit or hinder effective dissemination of knowledge to the understanding of the content by the students. Such variables may be lack of qualified teachers, teachers' qualification, experience and method of teaching, inadequate teaching facilities in schools and so on. In this vein, teacher factor has been linked to be one of the causes of students' poor performance, in this sense there is need to look into the quality of teachers in our secondary schools because effective teaching elicit effective learning. A Teacher is the principal initiator of learning. Therefore, the problem of this study is designed to survey the impact of teachers' qualification on students' academic achievement in Basic science in Oshimili South Local Government Area of Delta State.

Purpose of the Study

The main purpose of this study is to investigate on the impact of teachers' qualification on students' academic achievement in Basic science in Oshimili South Local Government Area of Delta State. Specifically, the study is set to.

1. Determine the impact of teachers' qualifications on students' academic achievement in Basic Science.
2. Investigate the impact of teachers' years of teaching experience on students' academic achievement in Basic Science.
3. Ascertain the impact of teachers' knowledge of subject matter on students' academic achievement in Basic Science.

Research Questions

The study sought to find answers to the following research questions.

1. What is the impact of teachers' qualifications on students' academic achievement in Basic Science?

2. Does teachers' year of teaching experience affect students' academic achievement in Basic Science?
3. What is the impact of teachers' knowledge of subject matter on students' academic achievement in Basic Science?

Methodology

A total of three (3) research questions were raised in order to investigate the impact of teachers' qualification on students' academic achievement in Oshimili South Local Government Area of Delta State. The study adopted a descriptive survey research design and random sampling technique in selecting a representative sample of 42 teachers as respondents in seven (7) selected Secondary Schools in Oshimili South Local Government Area of Delta State. The instrument for data collection was questionnaire designed by experts. The inputs of the experts helped to modify and improve the face and content validity of the instrument. The questionnaire contained (15) items. The level of agreement with each questionnaire items was determined based on the midpoint for the scale, which is 2.50. The items of the instrument was rated on a four-point rating scale of Strongly Agree (SA)=4, Agree (A)=3, Disagree (D)=2 and Strongly Disagree (SD)=1. The reliability coefficient of the instrument was 0.8 obtained using Test Re-test method. The data were analyzed using mean statistics and standard deviation.

Results

Research Question One: What is the impact of teachers' qualifications on students' academic achievement in Basic Science?

Table 1: Mean and Standard Deviation of the Impact of Teachers' Qualifications on Students' Academic Achievement in Basic Science

S/N	Statement	Mean	SD	Remarks
1.	Qualified <i>teachers</i> with high degree of knowledge have more understanding in practical work	3.0	1.12	Agree
2.	The qualification of basic science teachers affect the teaching and learning process	3.77	0.73	Agree
3.	Skills of teaching basic science increases as they acquire more qualifications.	3.22	0.97	Agree
4.	Basic science teachers' qualifications improve their social skills	3.47	0.88	Agree
5.	Basic science teachers' competence in teaching basic science increases by acquiring more qualification	3.17	0.71	Agree
Cluster Mean		3.33	0.74	

Table 1 revealed that the respondents agreed that item 1, 2, 3, 4 and 5 are acceptable with mean score ranging from 3.0 to 3.77 which are above the 2.5 cut off mark. This indicates that teacher qualifications influences students' academic achievement in Basic Science.

Research Question Two: Does teachers' year of teaching experience affect students' academic achievement in Basic Science?

Table 2; Mean and Standard Deviation of the Impact of Teachers' Years of Teaching Experience on Students' Academic Achievement in Basic Science

S/N	Statement	Mean	SD	Remarks
6.	Basic science teachers' experience and knowledge of subject matter improves the academic achievement of students	3.35	0.61	Agree
7.	Teachers, teaching experience enhances their knowledge	3.71	0.75	Agree
8.	Basic science teachers' experience enhances their skills and productivity	3.22	0.97	Agree
9.	Experienced basic science teachers are great asset to novice teachers who need advice, encouragement and continuous guidance in academic performance of students in basic science	1.67	0.52	Agree
10.	Experience teachers' acquire adequate ability and mastering to plan lessons.	3.53	0.74	Agree
Cluster Mean		3.09	0.72	

Table 2 revealed that the respondents agreed that item 6, 7, 8, and 10 are acceptable with mean score ranging from 3.22 to 3.71 which are above the 2.5 cut off mark while item 9 was rate disagreed by the respondent with a mean score of 1.67. This finding therefore, indicates that teachers' year of teaching experience affect students' academic achievement in Basic Science with a cluster mean score of 3.09.

Research Question Three

What is the impact of teachers' knowledge of subject matter on students' academic achievement in Basic Science?

Table 3; Mean and Standard Deviation of the Impact of Teachers' Knowledge of Subject Matter on Students' Academic Achievement in Basic Science

S/N	Statement	Mean	SD	Remarks
11.	Students of basic science learn best when taught by a teacher with a deep and conceptual understanding of the fundamentals of basic science	3.32	0.82	Agree
12.	Teachers skip some topics in the syllabus because of lack of background knowledge of those topics	3.33	0.75	Agree
13.	Teacher's attitude to basic science affects teaching and learning process	3.62	0.65	Agree
14.	Some basic science teachers give question asked by students as assignment and fail to attend to them later	3.0	0.95	disagree
15.	Basic science teacher gives every member of the class chance to express his or her opinion.	3.45	0.78	Agree
Cluster Mean		3.34	0.79	



Table 3 revealed that the respondents agreed that item 11, 12, 13, 14 and 15 are acceptable with mean score ranging from 3.0 to 3.62 which are above the 2.5 cut off mark. This finding therefore, indicates that teachers' knowledge of subject matter has a great influence on students' academic achievement in Basic Science with a cluster mean score of 3.34.

Discussion of Results

The finding of research question one in table 1 revealed that the respondents agreed that teachers' qualification influences students' academic achievement in Basic Science. This findings is in agreement with Nwagbo (2013) which suggest that even with the shortcomings of current teacher educational qualification and licensing, fully prepared and certified teaches are more successful with students than teachers without this preparation. In the same vein, (Hanushels and Rivkin, 2016) corroborates the above findings by asserting that Teacher's qualification is widely thought of as an essential determinant of academic performance.

The finding of research question two in table 2 revealed that the respondents agreed that teachers' year of teaching experience affect students' academic achievement in Basic Science. This finding is in agreement with findings of Buck, Bretz and Towns (2018)whom stated that teachers' experience and student achievement was that students taught by more experienced teachers achieve at a higher level than students taught by inexperienced teachers because the teachers have mastered the content and acquired classroom management skills to deal with different types of classroom problems. Furthermore, more experienced teachers are considered to be more able to concentrate on the most appropriate way to teach particular topics to students who differ in their abilities, prior knowledge and backgrounds Selvi (2012).

The finding of research question three in table 3 revealed that the respondents agreed that teachers' knowledge of subject matter has a great influence on students' academic achievement in Basic Science. This finding is in agreement with findings of Igwe (2015) who concluded that, in Basic sciences, there seems to be a trend that the students whose teachers have Basic sciences or Basic sciences education degrees demonstrate higher levels of achievement than students whose teachers lack degrees from Basic science. This characteristic is related to the subject-matter knowledge teachers acquire during their formal studies and pre-service teacher education courses.

Conclusion

Based on the results from the data analysis, it was concluded that the factors investigated: teachers' qualification, teacher knowledge of subject matter and teachers' experience work hand in hand with academic achievement of students in Basic Science. It examined how the experience and level of qualification influences the academic achievement of students in Basic Science in external examinations.



The result from descriptive statistics depicts that teachers with advance degree in education had higher percentage of students scoring.

Recommendations

Based on the findings of this study, the following recommendations were given by the researchers:

1. Teachers should be exposed to seminars and workshop to upgrade and enhance their knowledge in subject matter of Basic Science.
2. Government should only engage qualified teachers to teach students in school.
3. Government should employ highly experienced teachers in the teaching of social studies in school.
4. Educational administrators should organize seminars and workshops to update secondary school teachers on the need for qualification and experience in teaching.
5. Government should ensure that teachers with at least BSc. Ed in Basic Science are recruited to teach Basic Science at secondary school classes to gain experience with time.

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Repositioning and Enriching Physics Education in Nigeria for Sustainable National Development

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Abstract

The study discusses the current condition of physics education in Nigerian Schools. Physics education is a catalyst for sustainable national development as a result of its contributions to the significance progress of the nation. This paper is on the need for repositioning and enriching physics education for sustainable national development. It highlights the importance and challenges of teaching and learning of physics education towards enhancing a sustainable development technology in our Country. The problems facing physics education are; Poor equipped laboratory, inadequate funding, lack of well-trained physics oriented teachers and laboratory technologists, inappropriate curriculum, negative attitudes of students towards physics and poor physics facilities. To improve the state of physics education and repositioning it for sustainable development, adequate funding, well-equipped laboratory, review of physics curriculum, recruitment of qualified physics teachers, students' encouragement resource materials as well as Information Communication Technology (ICT) Awareness were all recommended.

Keywords: *Repositioning, Physics education, Technological development and Sustainable national development*

Introduction

Education is a veritable tool for national development. Globally, education is considered as a human right that should be accorded to all human beings. According to Federal Republic of Nigeria (2008), National Policy on Education states that education is an instrument par excellence for effecting national development. Physics education is an applied field which derived its authenticity from the facts that science as a field of endeavor is fundamental to human survival and hence must be seen as the right of every individual to learn. It acquaints students with certain knowledge, skills and attitudes needed for future work in physics and other science related fields. National Policy on Education (2004) chapter 5 Section 39, sub-section 1, "A greater proportion of educational expenditure will be devoted to science and technology".

According to Adegun (2003), the development of any society is judged by the technological level and the category of the people that inhabit it. A society with high level of technology would then be regarded as being developed. Physics education is a major factor in enhancing and enriching technological development. Physics as a



subject have become factor and crucial in science and technology for sustainable development worldwide because of their contributions to the material progress of nations. Generally, it is accepted that the adoption of physics is a prerequisite for national development (Akpan, 2010). Many authors have documented the roles of physics education in national development. According to Okeke, (2008), reported that rapid and sustainable development of a country is achieved through scientific research, knowledge and skills and rational application of science and technology. Okoli and Onwuachi, (2009) revealed that science and technology are tools for economic, social, and political development of a nation.

The national education scheme designed for Secondary School Physics in 1985 has it that the objectives of studying physics include, among others, to provide basic literary in Physics for functional living in the society and to acquire essential scientific skills and attitudes as a preparation for the technological application of Physics. Thus, for national development in technology, basic concepts and principles of Physics are indispensable. The teaching of Physics in schools is intended to produce young scientists who would be able to design the technological devices that would make day-to-day activities easier and living more comfortable (Ajayi, 2008). Thus, this implies that Physics is one of the pivotal subjects in national development and technology. Hence, the teaching and learning outcomes of physics education need serious attention in other to enhance and enriches a sustainable technological development in Nigeria. This can be achieved through restructuring of various aspects of science education.

Physics Education Concept

Physics education is a field of study concerned with producing a scientifically literate society. Physics education, has over the years gained prominence in the school curriculum worldwide. Physics education is an important sub-field within science education, with foci on the teaching and learning of physics both at secondary school and university level, as well as concerned with physics teacher preparation and development and public understanding of physics. Hence, physics is a systematic way of acquiring knowledge about natural world and hold the key to the progress and development of any nation (Jande and Dechi, 2007). According to Erinsho, (2009), Physics has been, and would continue to be of tremendous importance because of its ability to explain many natural occurrences and the central role it plays in the world's current technology development.

There is a symbolic relationship between physics and technology. Physics gives powerful tools to help express our creativity, contributes to the understanding of the world technology and to see the world in new dimension. Physics is useful and becomes impotent without knowledge and technology. The ability of a country or countries to improve the social welfare of the people is known as national development. The word sustainable development implies that the development should be sustained over a period of time, builds on the present and provides enabling



environment for future generations to develop and meet their needs (Okoli and Onwuachu, 2009). Technology which is the product of physics plays a fundamental role in wealth creation, improvement of the quality of life and real economic growth and transformation in any society. A developing country like Nigeria needs to advance to a better level by emphasizing physics at all levels of education and re-orient the entire society towards scientific thinking. On that note, (Egbogah, 2012) noted that sooner Nigeria realizes that her escape from poverty is predicted on her investment in science and technology education, the better for her.

Statement of the Problem

Much as Nigeria advocates for and pursuing development in technology, the result has been both unsatisfactory and encouraging (Adedayo, 2008). The development in technology is poor and contributes immensely to the state of underdevelopment in Nigeria (Ogbazi, 1987; Ajayi, 2007). There is need to redress and bring about a worthwhile growth in technology. Given that Physics is one of the major subjects meant to provide the basic developments needed in technology, its effective teaching and learning are crucial issues for consideration. In a research reports of (Ajayi, 2007; Adedayo, 2010) revealed that the performance of students in Physics is very appalling, this fact calls for attention. Therefore, the aims of this paper, this to discuss the challenges and enriching Physics education in Nigeria and as a means to compete fairly with other nations technologically

Challenges Facing Repositioning of Physics Education

Poor-equipped Laboratory

Most of the physics laboratories in Nigeria schools are poorly equipped. The success of physics education depends on the provision of laboratory facilities. Physics laboratory plays vital roles in science education as it provides students the opportunity to engage in the process of investigation and inquiry. In spite of these benefits, many schools in Nigeria do not have standard physics laboratory, while those available in some schools are ill-equipped for effective physics teaching Organization for Economic Cooperation and Development (OECD, 2008).

Inadequate Funding

One of the major challenges facing Nigeria in education sector is inadequate funding by federal, state, and local government. Over the years, education has been inadequately funded in Nigeria in spite of its roles in national development. Due to the low allocation to the educational sector, educational institutions have not been receiving adequate fund for science and technology provision (Uwaifo, 2010). Unfortunately in Nigeria, the low level of funding of schools makes it impossible to properly and adequately equip their workshops, laboratories, studios and classrooms suffice it to say that the necessary facilities needed for effective teaching and learning of science and technology are not adequately available in most Nigeria Schools. This problem is even aggravated by high cost of this equipment.

Lack of Well-Trained Physics Teacher

The impact of a teacher in the performance of students in Physics is germane. Teachers are facilitator who is to impact into the students' concepts expected to be learnt. (Olawaju, 1986; Nwagbo, 1995) revealed that most teachers teaching Physics are ignorant of the curriculum content of the subject. The students taught by these rather incompetent teachers would be invariably shallow in Physics concepts and principles. This agrees with the submission of (Ogbazi, 1987) that one of the problems of industrial development in Nigeria is that of inadequacy of sufficiently trained human resources. This has been a major constraint to the rate of technological and economic development in Nigeria. On another perspective, some Physics teachers who are masters of their subject lack the technical know-how of impacting the concepts to the students. One thing is to be well grounded in the conceptual understating of a subject; another thing is to be well acquitted with the best method to pass the concepts across to the learners for proper comprehension.

A professional teacher would be desirable in this regard.

The situation in most secondary schools in Nigeria is that Physics is taught by graduates in other fields of science such as B.Sc. Physics, Engineering; B. Tech Technology; HND etc. This set of people lacks the skills involved in teaching physics since they were not trained on the job. Fajonyomi (2007) argued that the success or failure of any educational program rests mainly on the adequate availability of well-qualified (professional) and dedicated teachers. The result of a study by Adedayo (2010) showed that professional teachers affect the students' performance in Physics positively more than the unprofessional teachers. Therefore, achieving qualitative physics education depends largely on the effectiveness and competency of the physics teacher in the schools (Ezeliora, 2005). This was confirmed by Animalu (2006) by stating that in most institutions of learning, physics is poorly handled because of the dearth of qualified physics teachers. This of course does not only lead to poor performance of the students but also leads to low enrolment of the students into physics courses. According to Ugwu, (2008) teachers are inadequate for physics education in Nigeria. Hence, the realization of the national growth in technology as highlighted in the National Policy on Education hinges largely on the quality of the physics teachers.

Inappropriate Curriculum

Poorly designed curriculum affects teaching of physics in schools. Effective physics education requires adequate curriculum content that would be able to address the societal need. Functional education is determined by the quality of the curriculum content and its implementation (Offorma, 2005). Functional physics curriculum content needs to be valid, relevant, significant, learnable, consistent with current societal realities of the country, useful and reflect the interest of the learners (Ivowi,



2009). The curriculum and instructions in African schools still reflect the colonial orientation which is devoid of African values and environmental factors. It is only recently that efforts are being geared towards reforming the curriculum to suit the needs of the society for which it is meant to serve (Ajayi, 2000), but the curriculum still lacks the values and materials that connects it to the immediate environment. In such case, the advocacy of technology as a means to satisfy the society would be a mirage. Hence, Physics curriculum that is poorly designed will definitely produce graduate that cannot find job in the labour market.

Negative Attitudes towards Physics

To the majority of the students in the secondary schools in Nigeria, Physics is perceived as a very difficult subject Soyibo, (1985). The impression cuts across the gender. Most parents do not help the situation in that through their comments and reactions, they scare their children and wards away from Physics. Ajayi, (2000) noted that students generally classified the three core science subjects Biology, Chemistry and Physics into level of difficulty. He reported that Biology is considered the easiest, followed by Chemistry and Physics being the most difficult subject. The cause of the negative perception of students towards Physics was identified by Adedayo, (2008) to include the fear of the mathematical skills involved, harsh teacher-students' relationship, students' unreadiness to study, preconceived bad information that Physics is a difficult subject and poor method of teaching. This impression greatly affects students' readiness and interest to the study of Physics. The consequence of this is felt on the expected technological growth of the country.

Unavailable Requisite Facilities

As the number of students enrolled to study physics in schools increases every day, the facilities in place to cater for the rising population are not readily available. This is mostly experienced during practical work. The quantity of available specimen and apparatus are nothing compared to the number of students involved in the practical work. This population explosion has an effect on students' achievement in physics education. The number of physics students has made it impossible for effective practical even in our higher institutions. Some of them do not even see the teachers or the experiment being demonstrated. This made it difficult for teachers to know their students well, understand how their minds work, and know what motivates them or their individual strengths and weaknesses. Okebukola, (2005) lamented on this factor and stated that large class size makes monitoring of students difficult and such overcrowded classroom is already straining existing facilities like lecture room where students stand to receive lecture. Most of the physics teachers do not use Information Communication Technology (ICT) tools like loud speaker, overhead projector which will enable them audibly pass instructions to the students. These challenges therefore, call for a repositioning of physics education for a better and sustainable development in Nigeria.



Strategies/Solutions for Repositioning Physics Education

Despite these challenges confronting physics education as discussed above, it is imperative that the relevance of Physics education in sustaining national development in Nigeria should be improved, if the country will breakthrough in this era. For actualization of physics education for sustainable national development, the following measures are suggested:

Well-Equipped Laboratory

Physics deals with practical concepts. Hence, it cannot be effectively taught and learnt without involving the practical activities. Considering the importance of laboratory, the school authority and government should make adequate provision to provide the necessary facilities, reagents needed and functioning equipment in Physics laboratory. Where the facilities are inadequate, the teacher should improvise. The teacher is also encouraged to make judicious use of the available materials for effective learning. This also calls for experienced laboratory technologists who will be assisting the physics teachers in conducting practical work. This would help to reduce the work load on the teacher and improve the efficiency of the teaching.

Curriculum Innovation

There is need for regular review of physics education curriculum. Efforts should be made to revisit the Physics curriculum content with the aim of catering for the needs of the society for which it is designed. Such effort would make Physics education relevant and useful. Those aspects that are too lengthy should be reduced and pave ways for the current trend in physics education. Emphasis should be laid on entrepreneurial subjects to enable students prepare for labour market, also be self-employed after graduating from higher institution.

Well Adequate Funding

For effective teaching and learning of proper physics education, government should improve funding of science and technology education for the provision of infrastructure, equipment and materials needed by the teachers for quality instruction in schools to guarantee qualitative teaching of science education. Both state and federal governments in Nigeria should improve budgetary allocation to science education sector. Government should partnering with stakeholders and private sectors in the funding of science education and direct the science and technology-related establishments such as oil companies, industries to pay a certain percentage of their annual income to the government for promotion of science education in Nigeria. The relevant agencies like Tertiary Education Trust Fund (TETFUND) should also monitor the institutions to ensure that funds released are well properly utilized.

Teachers' Training Programme

The attainment of goals of physics education is largely dependent on the quality of teachers and the level of their understanding of the subject content coupled with the



appropriate skills of imparting the knowledge. There is need for proper and/or regular training of the teachers at all levels both professional and non-professional teachers. Conferences, seminars and workshops, scholarship for further study, research grants for innovative teaching and learning processes are all needed in teaching and learning of science education. Also, emphasis should be placed not only on the mastery of their subject matter but as well as on improvisation methods, methodology, practical skills etc. Therefore, this will minimize the challenges of learning processes, enhance and enrich the teaching processes of science education.

Students' Encouragement

The students are the focus of all activities involved in Physics education. The teacher has a skillful role of making the subject (Physics) interesting and captivating for the students. The teacher's relationship with the students both inside and outside the classroom should not scare them away but rather draw their interest towards the study of Physics. Physics must be presented to the students as a subject that deals with Physical phenomena around them; this is a fact which has been eluding the students. The students should be sensitized as to the relevance of Physics in other fields of human endeavors such as Medicine, Pharmacy, Geophysics, Engineering, etc. The awareness of the link between Physics and other fields of study would leave the students with desire and readiness to learn the subject.

Information Communication Technology (ICT) Awareness

The use of ICT in the teaching and learning of Physics should be encouraged. This would in the first place, serve as excitement to the learners and more importantly makes learning interesting, involving and effective. The use of Computer Assisted Learning (CAL) has many advantages: Students can learn at their own pace and at a convenient time, Students are exposed to different presentations by different teachers, Students are not affected/influenced by their peer groups. It is a suitable tool where teachers are not totally adequate, Noise distraction is reduced. Students who feel shy can readily benefit from personal interaction with the computer and the ability to display animated or graphic image presents the students with more teaching aids.

Government

Apart from providing adequate relevant functioning materials and equipment for the Physics laboratory, the government also has the responsibility of providing motivation for the Physics teachers through incentives and worthwhile science allowances.

Conclusion

This paper attempted to justify the relevance of Physics in the repositioning and enriching physics education in Nigeria for sustainable national development. This is imperative due to the fact that Physics is a pivotal subject for technological

development. This also identified some of the challenges militating against Physics education in the Nigerian secondary schools and offered suggestions for improvement. It is pertinent to note that development can best be achieved when concerted effort is made by government in areas of repositioning physics education. Effective teaching and learning of Physics would undoubtedly influence positively the sustainability of technological development in Nigeria. If Nigeria is to develop and build a self-reliant nation, emphasis has to be made continually on the development, growth and restructuring of physics education in our school system.

Recommendations

1. Curriculum should be planned in such a way to accommodate the relevant and usefulness of physics in terms of the learner's goal and purposes.
2. Government and relevant stakeholders should make provision for modern infrastructures standard and adequate number of physics teachers should be trained.
3. A well-structured physics laboratory with appropriate facilities such as apparatus, equipment and machines for physics practical activity should be provided in our secondary schools and higher institution of learning.

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Introducing Bring Your Own Devices (BYOD) in Higher Institutions in Nigeria: Benefits, Challenges and Mitigating Technologies

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Abstract

Institution of higher learning is a place where students are expected to be exposed to the practical aspect of their field of learning. This is especially necessary for the students in sciences and engineering. Unfortunately, higher institutions in Nigeria are all complaining of low budgetary allocation. As a result of this, most of the institutions are poorly equipped with devices necessary for practical learning. Bring your own device (BYOD) encourages people to use their devices for academic, professional and personal purposes. In the context of this paper, BYOD is a technology that encourage students to bring their devices to their schools for the purpose of learning. The devices are required to be used in line with the institutional guidelines and policies while in the school environment but at the same time serving the students personal needs, since the device belongs to the student. This technology comes with many benefits such as improving the academic performance of the students, equipping the students with practical knowledge of their field, improving students' confidence when in the midst of their counterparts from other institutions among others. It is equally associated with some challenges such as loss of device, security breaches among others. It is recommended that institutions should have strict policies that will govern the use of these devices in school environment. Also institutions should provide some kind of palliatives for those who brought their devices, like free internet access for mobile devices and laptops among others.

Keywords: *Bring your own device, institutions, students, Mobile device, equipment, school environment.*

Introduction

Education in the world of today is technology driven. Mobile technology is integrated in virtually all aspects of our daily lives ranging from homes, offices, schools and public spaces. It is now quickly becoming part of the school environment and, educators and students are adopting it. This makes learning both interesting and innovative to learners and educators. This has also come with great challenge to both teachers and students. The use of technological devices such as computer and other portable mobile devices in higher institutions are to be implemented on one student to one device basis. Some developed countries of the world have solved this problem by introducing “Bring your own device” (BYOD) technology in their institutions (Safar, 2018).



BYOD is defined as portable consumer technology that has internet connectivity feature and it is owned by the student. Disterer and Kleiner (2013) describes BYOD as mobile computing devices which are used in offices, schools or can be used for both professional and private purposes, even if the device was provided by either the schools or the students. BYOD allows students to bring mobile devices of their choice like, iPads, tablet devices, laptops and notebooks (Walden University, 2023). This will help to promote one to one usage of devices by students in class (Boyd, 2015). This BYOD is meant to bring educational technology to the front of the class and keep it there. Seeing that mobile devices are now common in the private lives of students, this has turned out to be beneficial because it encourages convenience on learning. Also, students will most likely be more comfortable utilizing their personal technology device for academic purposes with regards to the fact that they are more familiar with the personal device than any other device provided by their schools for academic purposes. This concept has been adopted also in higher institutions so as to boost learning.

Before the BYOD era, higher education institutions provided computer labs and desktop computers for students to use. However, as technology rapidly advanced and became more portable and affordable, students began to prefer using their own devices for academic purposes. The history of BYOD in higher education can be traced back to the early 2000s but gained significant momentum with the introduction of smart phones (Moreira, Ferreira, Santos, & Durão, 2017). It has revolutionized teaching and learning, allowing students to access information and collaborates anytime and anywhere. However, it has also brought forth challenges in terms of security and infrastructure development (Lawrence 2018). The COVID-19 pandemic further emphasized the importance of BYOD in higher education as remote learning became the norm. The widespread adoption of smart phones, tablets, and laptops presented new opportunities and challenges for higher education institutions. On one hand, BYOD allowed students to have access to information and resources anytime and anywhere. On the other hand, it necessitated the development of robust Wi-Fi networks and infrastructure to support the increased demand (Kock, De & Futcher, 2016).

BYOD also presented challenges in terms of security, as institutions had to ensure the protection of sensitive data and information (Dhingra, 2016). This led to the implementation of strict security policies and the use of virtual private networks (VPNs) to secure connections between students' devices and the institution's network. To harness the potential of BYOD in enhancing teaching and learning experiences, many higher education institutions started encouraging its use. They developed mobile apps, learning management systems, and online platforms that were compatible with multiple devices and operating systems. This allowed students to access course materials, collaborate with peers, and participate in online discussions using their own devices.

Furthermore, BYOD facilitated the integration of technology into the classroom. Professors began utilizing interactive whiteboards, polling tools, and multimedia presentations to create engaging and interactive learning environments. This shift not only improved student engagement but also prepared them for the digital workplace. (Sundgren, 2019)

The COVID-19 pandemic further accelerated the adoption of BYOD in higher education (Binitie, Onochie, &Owolabi, 2020). With the sudden shift to remote learning, students and professors heavily relied on their personal devices to continue their academic activities. This period highlighted the importance of a flexible and adaptable BYOD infrastructure in higher education. Unfortunately, this has not been the case in Nigeria higher institutions. Funding of higher institutions has been a difficult issue to the government, hence the incessant industrial actions in higher institutions in Nigeria. One of the issues raised by Academic Staff Union of Universities (ASUU) during their last industrial action was lack of technological equipment for teaching the students (Ezeja, 2022). Some institutions resort to theory even in practical courses due to lack of necessary devices or gadget required for teaching the courses. This has led to graduating students that are theoretically sound but practically useless into a technology driven labor market.

Theoretical Framework

"Bring Your Own Device" (BYOD) concept allows students and faculty to use their personal devices, such as smart phones, laptops, and tablets, for educational purposes within the higher education setting. This approach has gained popularity due to the widespread adoption of mobile technology and the potential benefits it offers in terms of access to information, collaboration opportunities, and personalized learning experiences. Many higher institutions around the world mostly in developed countries has adopted this concept. Some of the universities are discussed below;

- a. University of California, Irvine, USA has implemented a BYOD program that allows students to connect their personal devices to the university's wireless infrastructure, enabling them to access resources and collaborate with fellow students. (Sanchez, Lopez-Belmonte, Moren-Guerrero, Reche, & Cabrera, 2020).
- b. King's College London, UK has embraced BYOD by encouraging students to bring their own devices and use them in classes and lectures. The university also provides support and guidance on how to effectively utilize personal devices for academic purposes. (Zahadat, Blessner, Blackburn, & Olson, 2015).
- c. Portuguese University, has implemented a BYOD policy that enables students and staff to connect personal devices to the university's network, giving them access to online learning tools, digital libraries, and collaborative platforms. (Moreira et al., 2017)

- d. The King Saud University, Saudi Arabia encourages students to bring their own laptops, tablets, and smart phones to enhance their learning experience. The institution offers a comprehensive wireless network infrastructure and provides technical support to facilitate BYOD. (Almarhabi, Bahaddad, & Alghamdi, 2022)
- e. University of Johannesburg, South Africa has adopted a BYOD strategy that allows students to use their personal devices for academic purposes. It provides a secure digital platform for students to access course materials, collaborate with peers, and communicate with professors. Kock De & Futcher, 2016).

These are just a few examples of higher institutions around the world that have embraced BYOD to enhance the educational experience for their students. Many authors have carried out research on the adoption of BYOD technology in Institutions. Some of these works considered its history, while some considered the benefits and risk associated with it. Hauptman (2015) provided an overview of the history and implications of Bring Your Own Device (BYOD) initiatives in higher education, specifically focusing on the role of IT departments. The research highlighted the challenges and benefits associated with BYOD programs and provide insights for IT departments on how to successfully implement and manage such initiatives. Siani (2017) explored the use of Bring Your Own Device (BYOD) as a pedagogical strategy in higher education. They provided a historical perspective on the evolution of BYOD in educational settings and discuss its impact on teaching and learning. The authors also address the challenges and opportunities of implementing BYOD programs and offer practical recommendations for integrating students' personal devices into the learning environment.

Song and Kong (2017) examined the challenges and opportunities of implementing Bring Your Own Device (BYOD) initiatives in higher education. They discussed the historical context of BYOD adoption and highlight the benefits and risks associated with such programs. The authors also outlined strategies to address security and privacy concerns in BYOD environments. Cheng, Guan, and Chau (2016) provided a comprehensive overview of the history of Bring Your Own Device (BYOD) in education, examining its origins and evolution in K-12 and higher education settings. They discussed the impact of BYOD on teaching and learning, explores the challenges and benefits of BYOD initiatives, and offers insights into the future trends and implications of BYOD in colleges and universities. Kadimo, Mutshewa, and Kebaets (2022) examined the history of Bring Your Own Device (BYOD) policies and practices in higher education. The authors discussed the perceptions and challenges associated with BYOD implementation and provide insights into the

reasons why institutions adopt BYOD programs. The authors also presented findings from a survey conducted to gather data on BYOD practices in higher education settings.

Benefits of BYOD in Institutions

Bring Your Own Device (BYOD) policies in higher institutions are becoming increasingly popular in recent years. There are several reasons why BYOD is gaining popularity in higher institutions. Firstly, it allows students and staff to use devices they are already comfortable with and have personalized settings and applications installed (Renard, 2023). This can enhance productivity and efficiency in the learning and teaching process. Secondly, implementing BYOD policies can save institutions money on purchasing and maintaining hardware and software. Instead, the focus can be shifted towards providing faster internet connectivity and other infrastructure improvements. Furthermore, BYOD encourages digital literacy among students and staff, as they are required to learn and operate technology for educational purposes. (Rahat, 2014). This can prepare them for the digital workplace and increase their employability skills (Dhingra, 2016). Both students and Staff benefit from BYOD implementation. Some of these benefits are discussed as follows:

1. **Constructivism:** BYOD aligns with the constructivist learning theory, which emphasizes active, experiential learning and knowledge construction. With their own devices, students can engage in interactive activities, access relevant resources, and collaborate with peers to construct their understanding of course topics. This learner-centered approach supports the development of critical thinking, problem-solving, and creativity skills.
2. **Ubiquitous learning:** BYOD also encompasses the concept of ubiquitous learning, where learning can occur anytime and anywhere. By integrating personal devices into the learning environment, educational institutions can create a seamless learning experience that extends beyond the physical classroom. Students can access course materials, participate in discussions, and complete assignments using their own devices, providing flexibility and convenience.
3. **Technology acceptance model:** The Technology Acceptance Model (TAM) is a theoretical framework that explains individuals' acceptance and usage of technology. In the context of BYOD, TAM suggests that students and faculty are more likely to adopt and utilize their personal devices for educational purposes if they perceive them as easy to use, useful, and compatible with their existing practices. Institutions need to ensure device compatibility, provide technical support, and promote the benefits of BYOD to improve acceptance and usage.

4. **Increase in students comfort:** Some students find it difficult familiarizing themselves with new devices or different devices from the one they use at home. In such a situation, using devices they are familiar with makes learning easy for them. This also means that they can use the devices comfortably without any hassle. This will boost their level of concentration in the class. Using school owned devices will restrict their use of the device for academic approved use only, but with their own device they have the option of personal use, and this allow for flexibility in their learning. Students can also make sure that their devices are working without having to turn the teacher or a technology expert.
5. **Promotes effective learning:** Most of the new capabilities of these devices make learning easier for the students. The devices also helps to increase their retentive capability. To be able to achieve all these, students are required to know how the device works very well. Therefore using their own devices will promote effective learning. The training process for the devices are also boycotted due to the familiarity that students have with their own device
6. **Use of cutting edge devices:** With BYOD students' personal devices tend to be more cutting-edge. It makes it easier for schools to be more up-to-date with technology. Institutions can benefit from the recent technology and more powerful device capabilities.
7. **Promotes continued learning outside school:** Since students have all the instructional materials, all the features and apps that makes learning engaging on their device, they are more likely to continue learning even when outside the school environment.
8. **Respect for the device:** Students tend to be more careful with their personal devices than with devices from school. Using their own device will promote careful handling of these devices by the students.
9. **Improved Learning outcome:** BYOD makes it easier to access academic data, e-mails, documents and other information remotely. It has profoundly transformed the way institutions carry out teaching and learning. Lectures are no longer restricted to a particular classroom, building or computer system. Students now have the flexibility and comfortability to continue learning from almost any location, and at any time of the day. The smart device has been transformed to an educator on the go.
10. **Cost Effectiveness: BYOD** helps school to save cost on purchase of technological devices. With BYOD, institutions and government can minimize cost of funding the school. The students will have to covers the cost of purchasing the device. This means that it is not the organization that pays for the device acquisition and upkeep. Generally, smartphone users tend to update and upgrade their devices more often than corporate bodies would

normally do. The problem of maintenance is highly reduced, the responsibility of device maintenance is less on the organization and relies more on the employees, and this also saves the organization the cost of carrying out regular maintenance and device upgrades. This greatly reduces the cost of running the institutions, by reducing the number of devices that the institutions or government have to purchase for students' use. The money saved on these could be channeled to another area of academic importance. It can equally be leased to students who cannot afford such devices to purchase their own devices.

Challenges of BYOD Implementation in Institutions

Implementing a BYOD (Bring Your Own Device) policy in higher education institutions can be a complex process that poses several challenges. Some of the challenges include:

1. **Digital Divide:** The digital divide refers to the unequal access to technology and the internet among different socio-economic groups. While BYOD can enhance access to educational resources for those who already own devices, it can also perpetuate existing inequalities. Institutions must consider strategies to bridge this digital divide and ensure equitable access to devices and connectivity for all students, regardless of their background. (Garba, Armarego, Murray, & Kenworthy, 2017).
2. **Information Privacy and Security:** Allowing personal devices on campus networks increases the risk of security breaches and unauthorized access. Different devices may have varying levels of security protocols or may be more susceptible to malware and viruses. Institutions need to have robust policies and security measures in place to protect sensitive data and ensure compliance with relevant regulations. This includes strategies such as data encryption, secure network protocols, and user authentication mechanisms. The most prominent risk that institutions implementing the BYOD technology will most likely encounter is that of security breaches, when students access sensitive company data from an unsecure network, the possibility of malicious attacks, virus attacks, data theft and unprotected sites are all factors that can leave a school's network at risk for cyber-attacks through students' personal mobile devices. Though some students may apply certain security measures, these measures may still not be strong enough to withstand certain attacks. BYOD exposes institutions network to security threats because the students' devices might store some sensitive institutions data on personal devices that are not permanently stationed in the school building. It is difficult for the institution to implement certain schools security measures on students' personal device without interfering with certain students' personal activities on their devices (Singh, Chan, & Zulkefli, 2017).

3. **Device Compatibility:** Higher education institutions typically have diverse student populations from different socio-economic backgrounds, which means students may use a wide range of devices, operating systems, and software versions. Ensuring compatibility across all these devices can be a significant challenge (Ogbene, Binitie, & Joe-Obasi, 2019).
4. **Network Infrastructure:** The existing network infrastructure may not be equipped to handle the increased number of devices connecting to it. If the Wi-Fi system is not upgraded to accommodate the additional load, it can result in slow internet speeds, connectivity issues, and network congestion.
5. **Support and Maintenance:** Supporting a wide variety of devices with different operating systems and configurations can be challenging for an institution's IT support team. IT staff may need to be trained on a broader range of devices, and troubleshooting can become more time-consuming and complex.
6. **Privacy Concerns:** BYOD policies raise privacy concerns among both students and staff. Personal devices used on campus networks may inadvertently expose personal data and pose a risk to privacy. Institutions must establish clear guidelines and policies to protect privacy and educate users on best practices (Zahadat, 2015).

Possible Mitigation Technologies of BYOD Security Challenges

There are several mitigation technologies that can help address the security challenges associated with BYOD (Bring Your Own Device) policies. Here are some examples:

1. **Mobile Device Management (MDM):** MDM solutions provide IT administrators with capabilities to manage and control mobile devices. It enables them to enforce security policies, remotely configure devices, and remotely wipe data in case of a security breach (Moreira et al., 2017).
2. **Containerization:** Containerization separates personal and corporate data on mobile devices by creating secure containers that isolate corporate apps and data from the rest of the device's environment. This segregation helps protect sensitive corporate information from potential risks (Sundgren, 2017).
3. **Virtual Private Network (VPN):** VPNs can establish secure connections between remote devices and corporate networks. By encrypting data traffic, VPNs mitigate the risks associated with data interception and unauthorized access (Stone, 2014).
4. **Network Access Control (NAC):** NAC systems authenticate and authorize devices before granting them access to corporate networks. This technology can verify the security posture of devices based on their compliance with security policies, ensuring that only secure devices are allowed access.

(Cuevas de las, Mora, Merelo, Castillo, Garcý'a-Sa' nchez, &Ferna' ndez-Ares, 2015).

5. **Mobile Application Management (MAM):**MAM solutions help monitor and manage mobile applications, allowing administrators to enforce policies, control access to corporate resources, and remotely wipe sensitive data from specific applications (**Aggarwal, Sharma, &Saxena, 2023**).

These mitigation technologies can significantly enhance the security of BYOD environments by implementing various security controls and enforcing policies to protect sensitive corporate data.

Conclusion

The BYOD technology brings more flexibility to learning experience. It improves the learning outcome in the long run. Both institutions and students will benefit from its implementation. Many higher institutions in developed countries has adopted it and they are reaping the benefits today. Seeing that it reduces the cost of running institutions, it will be of great benefit to Nigerian institutions that find it difficult to receive enough funding from the Federal government. However, the major challenge of security can be handled if the suggested technologies are adopted alongside its implementation.

Recommendations

Before the BYOD technology is implemented, it is necessary for the institutions and governments to collaborate and;

1. Provide free network for students round the campus. This will serve as an incentive to parents who sponsored their children to obtain those devices.
2. Provide loan facility for students whom their parents cannot afford the devices. This will help the student not to miss out.
3. Create a comprehensive policy that outlines the rules and guidelines for using personal devices on campus. The policy should address areas such as device compatibility, security measures, data privacy, app restrictions, and consequences for non-compliance.
4. Ensure that the campus network infrastructure is robust and capable of handling a large number of devices. Implement strong security measures like firewall protection, intrusion detection systems, and encryption to safeguard the network and data from potential threats.
5. Establish an IT support system to assist students and faculty in setting up and troubleshooting their personal devices. This can include providing resources like Frequently Asked Questions (FAQs), online forums, or technical staff to assist with device configuration.
6. Conduct training sessions or workshops to educate users about the risks associated with BYOD and the best practices for using personal devices

- securely. Make sure to emphasize the importance of installing software updates and using strong passwords or biometric authentication to prevent unauthorized access.
7. Encourage users to be vigilant about cyber security by promoting good practices like avoiding suspicious links or downloads, using multi-factor authentication, and reporting any security incidents. Regularly communicate security tips and reminders through various channels to keep users informed and engaged.
 8. Emphasize the importance of regularly backing up data stored on personal devices to prevent data loss in case of theft, damage, or system failures. Provide resources or recommendations on cloud-based backup solutions to facilitate data protection.
 9. Regularly gather feedback from users and evaluate the effectiveness of the BYOD implementation. This feedback can help identify areas for improvement and allow for necessary adjustments in the policies and practices.

By following these recommendations, higher institutions can successfully implement BYOD programs while maintaining the necessary security measures to protect sensitive data and ensure a productive learning environment.

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Strategies For Promoting Science, Technology And Computer Education In Nigeria

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Abstract

Science, technology, and computer education play a crucial role in the economic development and social progress of nations. In Nigeria, there is a growing need to enhance these fields to address the challenges of the modern world and foster innovation. It is on this ground that the teaching and learning of Science Education is giving a precedence, focus and attention in terms of its implementation strategies. Science and technology have employed numerous strategies to promote the development of enterprises to ensure that the increasing number of unemployed youths and economically productive adult population are gainfully involved in meaningful national development. This article explores various strategies to promote science, technology, and computer education in Nigeria, including curriculum development, teacher training, infrastructure improvement, industry collaboration, and public awareness campaigns. By implementing these strategies, Nigeria can create a vibrant ecosystem that empowers its citizens and contributes to national development.

Keywords: Science education, Technology education, Computer education, Nigeria, Curriculum Development

Introduction

Science, technology, and computer education are vital components of a nation's development, enabling innovation, economic growth, and improved standards of living. In Nigeria, promoting these fields is essential to address the challenges of the 21st century and position the country as a global player in technology and innovation. This article presents strategies to enhance science, technology, and computer education in Nigeria, aiming to strengthen the education system, empower learners, and foster a culture of scientific inquiry and technological innovation. Since, science, technology, and computer education are essential components of modern education, driving innovation, economic growth, and sustainable development, Nigeria, like other developing countries, faces significant challenges in promoting science, technology, and computer education, hindering its socio-economic progress. This research aims to examine effective strategies for promoting science, technology, and computer education in Nigeria, addressing the country



'specific challenges and leveraging its unique opportunities. This research is crucial because Nigeria's economic growth and development depend on its ability to cultivate a skilled workforce in science, technology, and computer education. The country faces a significant shortage of qualified professionals in these fields, hindering its ability to compete globally. By identifying effective strategies for promoting Science, Technology, and Computer Education, this research aims to contribute to Nigeria's economic transformation, improve its citizens' quality of life, and enhance its global competitiveness.

One crucial strategy for promoting science, technology, and computer education in Nigeria is curriculum development. Updating and aligning curricula with current trends and emerging technologies is essential to equip students with relevant knowledge and skills. The Federal Ministry of Education (2014) provides the National Policy on Education, which serves as a guiding framework. The Nigeria Educational Research and Development Council (NERDC, 2019) contributes by establishing the Minimum Standards for Basic Education in Nigeria, ensuring a consistent curriculum across the nation. These contributions help shape the direction and content of the curriculum.

Investing in teacher training programs is another crucial strategy for promoting science, technology, and computer education. Teachers need the necessary knowledge and pedagogical skills to effectively deliver science and technology concepts to students. The National Teachers' Institute (NTI, 2022) offers Professional Development for Science and Technology Teachers in Nigeria, providing specialized training to educators. This initiative by NTI enhances the capacity of teachers to deliver quality instruction in science, technology, and computer education. The Nigerian Educational Research and Development Council (NERDC, 2020) contributes by producing the In-service Training Manual for Science and Technology Teachers in Nigeria, serving as a resource for teacher professional development.

Infrastructure improvement is critical to support science, technology, and computer education. Equipping schools with modern laboratories, computer labs, and internet connectivity facilitates hands-on experimentation, research, and access to online learning resources. The National Information Technology Development Agency (NITDA, 2018) provides guidelines for School Knowledge Centres in Nigeria, outlining the infrastructure requirements for educational institutions. These guidelines contribute to the development of state-of-the-art infrastructure that enables effective science, technology, and computer education. The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2020) emphasizes the importance of infrastructure development in its Education for Sustainable Development: A Roadmap publication, highlighting the need for sustainable and inclusive infrastructure to support quality education.



The National Universities Commission (NUC, 2021) provides guidelines for University-Industry Collaboration in Nigeria, facilitating the establishment of collaborative initiatives that bridge the gap between academia and industry. Collaboration between educational institutions and industries is crucial for promoting science, technology, and computer education. Olaniyan (2019) highlights the opportunities and challenges of industry and university collaboration in Nigeria, emphasizing the benefits of partnerships with technology companies, research organizations, and start-ups. Such collaborations provide students with real-world exposure, internships, and mentorship opportunities, enabling them to apply scientific and technological concepts in practical settings.

Raising public awareness about the importance of science, technology, and computer education is vital to garner support and encourage participation. Akinbote (2021) emphasizes the role of mass media in promoting science education in Nigeria, highlighting the need for effective communication strategies to engage the public. Public awareness campaigns can showcase success stories, innovative projects, and organize science fairs to inspire young minds and cultivate a culture of curiosity and innovation. Omokhodion (2018) highlights the importance of enhancing public understanding of science and technology in Nigeria, suggesting various methods such as public lectures and community engagement.

Content of Science Curriculum and its Implementation

The content of the science curriculum plays a crucial role in shaping the knowledge and skills that students acquire in science education. It encompasses various scientific disciplines, including Biology, Chemistry, Physics, and environmental science, and is designed to provide a comprehensive understanding of the natural world and scientific processes. Adequate curriculum content is very important for effective science education. Muhammad (2011) stated that functional education is determined by the quality of the Curriculum Content and its implementation. Functional science curriculum content must be valid, relevant, significant, learnable, consistent with current social realities of the country, useful and reflect the interest of the learners, Iyowi (2009).

Akuma (2007) stated that valid curriculum must be related to the philosophy and objectives of education. Curriculum planners and developers according to Cooper (2013) attempted to take care of these issues but there are still some barriers to the attainment of goals of Science education in Nigeria. Some of the barriers according to Eley and Norton (2004) include, curriculum overload, overcrowded classes, population explosion in schools, and lack of motivation of the Science teachers by the government, poorly equipped laboratories, and examination malpractices among others. The present science and technology education curriculum in Nigeria advocate hands-on processes and skills acquisition, most of our children in both primary and secondary schools are not exposed to these real situations in schools. This means that the scientific, vocational and technical aspects of education of our

children are lacking. In some schools, there are no laboratories or workshops for practicals and where laboratories are available, practical works start very late, at times two weeks to the external SSCE/NECO practical (Ajaja, 2013; Muhammad, Bala, 2016).

The implementation of the science curriculum involves translating the curriculum content into effective teaching and learning experiences in the classroom. This section explores the key components of the science curriculum content and its implementation strategies

1. Science Curriculum Content

The science curriculum content typically covers a wide range of topics and concepts, aiming to develop scientific literacy and critical thinking skills among students. The content may include:

- a) **Fundamental Concepts:** These concepts form the foundation of scientific knowledge and include topics such as the scientific method, scientific inquiry, experimental design, and data analysis.
- b) **Disciplinary Knowledge:** The science curriculum covers key concepts and principles specific to various scientific disciplines, including Biology, Chemistry, Physics, and earth science. These concepts provide students with a deep understanding of each discipline's core ideas, theories, and applications.
- c) **Cross-cutting Concepts:** Cross-cutting concepts are overarching principles that span multiple scientific disciplines. Examples include patterns, cause and effect, systems and models, energy and matter, and stability and change. These concepts help students make connections across different areas of science.
- d) **Scientific Skills:** The science curriculum also emphasizes the development of scientific skills, such as observation, measurement, data collection and analysis, experimentation, problem solving, and scientific communication. These skills are essential for students to engage in scientific inquiry and investigations.
- e) **Nature of Science:** Understanding the nature of science is an important component of the curriculum. This includes learning about the characteristics of scientific knowledge, the process of scientific inquiry, the role of evidence in scientific reasoning, and the social and cultural aspects of science.

2. Implementation of the Science Curriculum

Implementing the science curriculum involves translating the curriculum content into effective teaching and learning experiences. The following strategies can support the successful implementation of the science curriculum:

- a) ***Inquiry-Based Learning***: Encouraging inquiry-based learning approaches enables students to actively explore scientific concepts, ask questions, conduct investigations, and develop their own understanding of scientific principles. This approach promotes student engagement, critical thinking, and problem-solving skills.
- b) ***Hands-on Experiments and Activities***: Providing opportunities for hands-on experiments and activities allows students to apply scientific concepts and theories in practical contexts. This hands-on approach fosters a deeper understanding of scientific principles, enhances problem solving skills, and encourages curiosity and creativity.
- c) ***Integration of Technology***: Integrating technology tools and resources into science instruction can enhance learning experiences and promote digital literacy. Virtual simulations, interactive software, data analysis tools, and online resources can support students' exploration and understanding of scientific concepts.
- d) ***Collaborative Learning***: Encouraging collaborative learning experiences, such as group projects, discussions, and debates, promotes peer interaction, communication skills, and teamwork. Collaborative activities also foster the sharing of ideas, diverse perspectives, and collective problem-solving.
- e) ***Real-World Connections***: Making connections between scientific concepts and real-world applications helps students understand the relevance and importance of science in everyday life. Providing examples, case studies, and guest speakers from various scientific fields can demonstrate the practical applications of scientific knowledge.
- f) ***Assessment Strategies***: Using a variety of assessment strategies, such as formative assessments, projects, experiments, and performance tasks, allows teachers to evaluate students' understanding of scientific concepts and skills. Assessments should align with the curriculum goals and provide feedback to guide instruction and support student learning.
- g) ***Professional Development for Teachers***: Providing ongoing professional development opportunities for science teachers is crucial for effective curriculum implementation. Professional development programs should focus on content knowledge, pedagogical strategies, inquiry-based teaching methods, and the integration of technology in science instruction.

By incorporating these strategies, educators can create a dynamic and engaging learning environment that promotes scientific inquiry, critical thinking, and a lifelong passion for science among students. The science curriculum content encompasses fundamental concepts, disciplinary knowledge, cross-cutting concepts, scientific skills, and an understanding of the nature of science.



Implementing the curriculum involves employing inquiry-based learning, hands-on activities, technology integration, collaborative learning, real-world connections, diverse assessment strategies, and providing professional development for teachers. Through effective implementation, the science curriculum can foster scientific literacy, critical thinking skills, and a deeper understanding of the natural world among students.

Content of Science Curriculum in Computer Education

Guzdial (2008) emphasizes the importance of considering the context in computer education. This contribution reinforces the need to align the content of the science curriculum in computer science with real-world applications and relevant contexts. The National Research Council (2010) highlights the intersection of science education and 21st-century skills. Their report emphasizes the importance of integrating skills such as computational thinking, problem-solving, and digital literacy into the science curriculum in computer science to prepare students for the demands of the 21st century. The Partnership for 21st Century Skills (2009) provides a framework for 21st-century skills, including computational thinking, critical thinking, and problem-solving. This contribution underscores the relevance of incorporating these skills into the science curriculum in computer science to equip students with the necessary competencies for success in the digital age.

Resnick et al. (2009) introduce Scratch, a programming language designed for educational purposes. Their work showcases the potential of using educational tools like Scratch to support the implementation of the science curriculum in computer science, promoting hands-on programming experiences and fostering creativity and collaboration. Wing (2006) introduces the concept of computational thinking, emphasizing its significance in problem-solving and its application across various disciplines. This contribution highlights the importance of integrating computational thinking skills into the science curriculum in computer science to develop students' abilities to approach complex problems systematically. The content of the science curriculum in computer education focuses on providing students with a comprehensive understanding of computer science concepts, skills, and applications. It encompasses a range of topics related to computer systems, programming, algorithms, data structures, computational thinking, and digital literacy. The content aims to develop students' computational thinking abilities, problem-solving skills, and proficiency in using technology. Here are some key components of the science curriculum content in computer education:

1. ***Fundamentals of Computer Science:*** The curriculum covers the fundamental concepts of computer science, including the structure and components of a computer system, data representation, computer architecture, and operating systems. Students learn about the basics of hardware, software, and the interaction between them.

2. **Programming Concepts and Languages:** The curriculum introduces students to programming concepts such as variables, data types, control structures, functions, and algorithms. It covers programming languages commonly used in computer science education, such as Python, Java, C++, or JavaScript. Students learn to write, debug, and test code to solve problems and create simple programs.
3. **Data Structures and Algorithms:** The curriculum includes the study of data structures, such as arrays, lists, stacks, queues, trees, and graphs. Students learn how to implement and use these data structures to store and manipulate data efficiently. They also learn algorithms for sorting, searching, and problem-solving.
4. **Computational Thinking:** Computational thinking is a key component of the curriculum, emphasizing the ability to analyze problems, break them down into smaller parts, and develop algorithmic solutions. Students learn to think logically, reason abstractly, and approach problems in a systematic and algorithmic manner.
5. **Web Development and Design:** The curriculum may cover the basics of web development, including HTML, CSS, and JavaScript. Students learn to create and design web pages, understand the principles of user interface (UI) and user experience (UX) design, and explore web technologies and frameworks.
6. **Data Science and Analysis:** The curriculum may introduce students to data science concepts, including data collection, cleaning, analysis, and visualization. They learn how to use programming and statistical tools to process and interpret data, identify patterns, and draw meaningful insights.
7. **Ethical and Social Implications:** The curriculum addresses ethical considerations related to technology and computer science. It explores topics such as data privacy, cybersecurity, digital citizenship, intellectual property, and the impact of technology on society. Students learn to make responsible and ethical decisions in the use of technology.

Implementation of the Science Curriculum in Computer Education

Implementing the science curriculum in computer education involves employing effective teaching and learning strategies to facilitate students' understanding and application of computer science concepts. Here are some strategies for implementing the curriculum:

1. **Hands-on Programming Projects:** Providing students with hands-on programming projects allows them to apply their knowledge and develop coding skills. Students engage in practical coding exercises and develop real-world applications to reinforce their understanding of programming concepts.

2. **Coding Challenges and Competitions:** Organizing coding challenges and competitions can motivate students to improve their programming skills. These events foster healthy competition, problem-solving, and critical thinking abilities among students. Students can participate individually or in teams to solve coding problems within a given time frame.
3. **Project-Based Learning:** Engaging students in project-based learning activities encourages them to work on complex problems or develop software solutions. Students collaborate, plan, design, and implement projects, applying their knowledge and skills to solve real-world problems or create innovative software applications.
4. **Collaborative Learning:** Promoting collaborative learning allows students to work in teams, share ideas, and collectively solve problems. Group activities, discussions, and peer feedback help foster communication skills, teamwork, and the ability to work effectively in a team-based environment.
5. **Integration of Educational Technology:** Utilizing educational technology tools and resources enhances the learning experience. Virtual programming environments, online coding platforms, and interactive simulations can facilitate hands-on coding practice and provide immediate feedback. Educational software and applications can support concept visualization and provide engaging learning materials.
6. **Industry Partnerships and Guest Speakers:** Collaborating with industry professionals and inviting guest speakers from the technology sector can provide students with insights into real-world applications of computer science. Industry partnerships may also offer internship opportunities, mentorship programs, or guest lectures to expose students to current trends and industry practices.
7. **Continuous Professional Development for Teachers:** Providing teachers with ongoing professional development opportunities is essential to ensure they stay updated with the latest advancements in computer science. Professional development programs can focus on emerging technologies, programming languages, and pedagogical strategies for teaching computer science concepts effectively. By implementing these strategies, educators can create a dynamic and engaging learning environment that promotes computational thinking, problem-solving, and digital literacy among students in computer education.

Integrating Science, Technology, and Computer Education

The integration of science, technology, and computer education is a powerful approach to foster interdisciplinary learning and equip students with a holistic understanding of the interconnectedness of these fields. As proposed by Balogun and



Osagie (2020), creating cross disciplinary projects and activities that involve scientific investigations, technology applications, and computer programming can provide students with a comprehensive view of real-world problem-solving. By working collaboratively on integrated projects, students can see how scientific knowledge informs technological innovations and how technology, in turn, supports scientific inquiry and computational analysis.

Establishing STEM Centres and Maker Spaces

To support hands-on learning and foster a culture of innovation, Adegoke and Afolabi (2019) suggest the establishment of STEM centres and maker spaces in schools and communities. STEM centres provide students with access to advanced technology, equipment, and materials for conducting experiments, building prototypes, and exploring creative solutions. Maker spaces, on the other hand, are collaborative workspaces that allow students to tinker, invent, and apply their science, technology, and computer skills in practical projects.

Promoting Gender Inclusivity in STEM

It is essential to address gender disparities in STEM fields and encourage more girls to pursue science, technology, and computer education. As highlighted by Adebayo and Okonkwo (2018), implementing targeted outreach programs, mentorship initiatives, and scholarships for female students can help break down gender barriers and increase female participation in STEM-related careers.

Leveraging Online Learning Platforms

The rapid advancement of digital technology opens up new opportunities for learning beyond the traditional classroom. Adejumo and Ibrahim (2020) propose leveraging online learning platforms to expand access to science, technology, and computer education, especially in remote or underserved areas. Online courses, interactive tutorials, and virtual laboratories can enhance students' learning experiences and provide access to resources not readily available in physical classrooms. By implementing these recommendations, Nigeria can create a robust ecosystem for science, technology, and computer education. This will help nurture a skilled workforce, drive innovation, and position the country at the forefront of technological advancements.

Conclusion

In conclusion, promoting science, technology, and computer education in Nigeria is crucial for addressing the challenges of the modern world and fostering innovation. This article has explored various strategies to enhance science, technology, and computer education in Nigeria, including curriculum development, teacher training, infrastructure improvement, industry collaboration, and public awareness campaigns. By implementing these strategies, Nigeria can create a vibrant ecosystem that empowers its citizens and contributes to national development.



The content of the science curriculum in computer education encompasses fundamental computer science concepts, programming, data structures, computational thinking, web development, data analysis, and ethical considerations. It provides students with a comprehensive understanding of computer science principles and skills necessary for the digital age.

The implementation of the science curriculum in computer education involves employing effective teaching and learning strategies. These strategies include hands-on programming projects, coding challenges and competitions, project-based learning, collaborative learning, integration of educational technology, industry partnerships, guest speakers, and continuous professional development for teachers. Through these approaches, educators can create an engaging and dynamic learning environment that promotes computational thinking, problem solving, and digital literacy among students.

By embracing these strategies and implementing a robust science, technology, and computer education framework, Nigeria can equip its citizens with the necessary knowledge and skills to drive innovation, economic growth, and societal progress. This will position Nigeria as a global leader in the digital age and contribute to the overall development of the country.

It is important to note that ongoing research, collaboration among stakeholders, and continuous evaluation and improvement are necessary to ensure the effectiveness and relevance of the science curriculum in computer education. By staying current with advancements in technology and educational practices, Nigeria can adapt and evolve its curriculum to meet the evolving needs of students and the demands of a rapidly changing world. Promoting science, technology, and computer education in Nigeria requires a multifaceted approach that leverages curriculum development, teacher training, infrastructure improvement, innovative teaching methods, integrates the STEM disciplines, fosters collaboration with industries, and supports equal access for all learners. By adopting the strategies advocated by these authors, Nigeria can nurture a skilled workforce, stimulate technological innovations, and position itself as a global leader in the knowledge-driven economy. Embracing the power of education in science, technology, and computer fields will not only benefit Nigeria's economic and social development but also contribute to solving global challenges through scientific advancements and technological breakthroughs

Recommendations

Based on the discussion of strategies for promoting science, technology, and computer education in Nigeria, the following recommendations were made:

1. The curriculum in science, technology, and computer education should be regularly updated to reflect current trends and emerging technologies. Collaboration among educators, industry professionals, and policymakers is

- crucial to ensure the curriculum remains relevant and aligned with the needs of the digital age.
2. Government should invest in teacher training programmes to equip educators with the knowledge and skills necessary to effectively deliver science, technology, and computer education. Training programs should focus on both subject matter expertise and pedagogical approaches that promote hands-on learning, critical thinking, and problem-solving skills.
 3. Schools should be equipped with modern laboratories, computer laboratory, internet connectivity, and access to educational software and resources. Government and educational institutions should prioritize infrastructure improvement to create conducive learning environments.
 4. Collaborating with industries, technology companies, research organizations, and start-ups is vital for bridging the gap between academic knowledge and practical applications. Partnerships can provide students with internships, mentorship opportunities, and exposure to real-world projects. Establishing industry advisory boards and promoting knowledge transfer can further strengthen the collaboration.
 5. Public awareness campaigns should be conducted to highlight the importance of science, technology, and computer education for national development. These campaigns can showcase success stories, innovative projects, and the impact of these fields on various sectors. Engaging the media, organizing science fairs, and promoting community involvement can help inspire and encourage interest in these subjects.
 6. Continuous research and evaluation of science, technology, and computer education initiatives are essential for measuring their effectiveness and identifying areas for improvement. Collaborative research projects involving academia, industry, and government can provide valuable insights into best practices and inform evidence-based decision-making.
 7. Governments should provide policy support and Adequate funding to prioritize science, technology, and computer education. This includes allocating resources for curriculum development, teacher training, infrastructure improvement, and industry collaborations. Policies should also aim to promote equitable access to quality education in these fields, considering gender balance and inclusion.

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Extent of the Use of E-Learning Facilities in the Teaching of Mathematics in Secondary Schools in Oshimili South Local Government Area Towards Sustainable National Development

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Abstract

The research work determined how knowledgeable the secondary school teachers are on e-learning in the teaching of mathematics in Oshimili South Local Government Area of Delta State. The study adopted a descriptive survey design and guided by three research questions. The population of the study comprises of one hundred and fifty (150) teachers in some selected secondary school in Oshimili South LGA. Structured questionnaire of 21 items was designed in four scales responses pattern was used for data collection. The face and content validity was determined by two lecturers from department of measurement and evaluation. A test-retest was carried out while Pearson's Product Moment Correlation Coefficient was 0.78 and certified that the instrument was fit for data collection. The analysis of data was carried out with tables to obtain the mean value. The result revealed that the teachers in secondary schools hardly make use of e-learning facilities in teaching mathematics in their various schools, which poses a very serious problem to our education system if the issue is not tackle urgently. Just like what will face during COVID-19 period where many schools where close down. The face and content validation were determined lecturers. One from department of Mathematics/Computer Science and the second from the Department of Education all in Federal College of Education (Technical) Asaba. The results from data analysis revealed that secondary school teachers hardly utilize e-learning software in teaching and learning of Mathematics topics. Some recommendations were made such as: school authorities should collaborate with government to ensure workshop for teachers in secondary schools, modern facilities like laptops, computer desktops should be made available for teachers in secondary schools, and also, school authorities should also try to invite some experts in the e-learning teaching to come and train teachers in their various schools..

Keywords: Mathematics, Teaching, E-learning, Sustainable development,

Introduction

E-learning is a learning utilizing electronic technologies to access educational curriculum outside of a traditional classroom (Adebayo, 2019). It involves the use of network technologies to create, foster, deliver and facilitate learning and it encompasses face-to-face, distance, mixed and blended delivery models that utilizes electronic means, a unifying term used to describe the fields of online learning, web



based training and technology delivered instructions. It is interactive in that you can also communicate with your teachers, professor or other students in your class. Using e-learning in teaching children is one of the way of bringing them face to face with the world which education intends to introduce to them- direct. Onaifoh (2015) in Sims (2008) sees e-learning as a tool that opens new ways of learning through the new models like the use of videos, tele-conferences which changes the process of teaching.

Ekwueme (2013) defined mathematics as a means of communicating and tools for solving problems in a wide range of context. However, Mathematics education is geared to make students problem solvers, critical and analytical thinkers, creative in manipulative skills that are very helpful in their daily activities. Onaifoh (2015) in Ekwueme (2013) sees mathematics as a systematic, organised and exact branch of science which involves the creation of human minds with ideas and reasoning. The use of E-learning cannot be over-emphasized based on its importance in the teaching of mathematics and other subject which brought a large development in the global world today.

However, using e-learning in the teaching and learning of mathematics has helped a lot of teachers and students, most especially during the COVID 19 in the advance nations. Since education is a vital activity and quality education has traditionally been associated with strong teachers having high degree of personal contact with learners. The important of education, particularly in a developing country like Nigeria has increase because of the need to catch up with the developed countries in several area, particularly in global competitiveness and best practices. As the world grows more towards being a global village, the need to innovate in teaching and learning with particular reference to Information and Communication Technology (ICT), becomes imperative if attempt is to be made to bridge the gap between the developing and developed world.

Moreover, there is need for mathematics teachers to adjust from the conventional methods of teaching to more technologically advanced methods of instruction delivery. The conventional teaching competencies needs to be urgently changed in order to obtain maximum benefit which e-learning technologies offer, hence mathematics teachers are faced with the responsibility of developing and updating themselves with the new model Information and Communication Technology (ICT) competencies required for education (Joseph & Ekemini, 2014). With the advancement of Information Technology in the 21st Century e-learning has become an invaluable technology for teaching, learning and research in Computer education (Otuka, 2011). The introduction on Information and Communication Technologies, however gave room to the new concept called “Electronic/ online learning of (e-learning)” (Okike, 2014). E-learning in education is the systematic integration of modern technologies and equipment. Teaching and learning of mathematics in

Nigeria cannot be fully relevant without adequate preparation of new generation of learners' effective use the Information and Communication Technology in their professional practices (Adebayo, 2019).

Statement of Problem

The need for the usage of e-learning facilities in the 21st century is very crucial and cannot be wave out because e-learning facilities have taken over the entire affairs of all areas of academic. However, in the teaching of mathematics as a subject it encounters problems that are difficult to solve in a face-to-face teaching framework for the beginners. Which lead to students paying little or no attention to understanding the basic mathematical concepts or it could be lack of motivation and interests (Abrmovitz, Berezina, Berman & Shvaetsnan 2017). The state of the art of communication technology is a persistent issue that described the current challenges of blended e-learning in mathematics. E-learning approaches supposedly to be an initiative toward linking the conventional teaching and programmes in mathematics education to virtual learning system, so as to benefit from the technology-based learning.

Purpose of the Study

The main purpose of the study is to determine the extent of the use of e-learning in teaching of mathematics in secondary schools in Oshimili South Local Government Area of Delta State.. Specifically, the study seeks to:

1. Investigate how often teachers uses e-learning software facilities in the teaching of mathematics topics in Oshimili South Local Government Area of Delta State.
2. Examine how often teachers used computer projector as a teaching tools in teaching of mathematics topics Oshimili South Local Government Area of Delta State.
3. Determine how often teachers used e-learning hardware facilities as a teaching tools in teaching of mathematics topics in Oshimili South Local Government Area of Delta State.

Research Questions

The following research questions were formulated to guide the study:

1. To what extent do teacher use e-learning software facilities in the teaching of mathematics topics in Oshimili South Local Government Area of Delta State.?
2. To what extent do teacher use computer projector as a teaching tool in teaching of mathematics topics in Oshimili South Local Government Area of Delta State.?
3. To what extent do teachers use e-learning hardware facilities as a teaching tool in teaching of mathematics topics in Oshimili South Local Government Area of Delta State.?

Methodology

The study followed a survey design. The target population comprises of all teachers of government secondary schools in Oshimili South Local Government Area of Delta State. The sample size of one hundred and fifty (150) teachers from fifteen secondary schools was used and was drawn using the simple random sampling technique. The instrument for data collection was structured questionnaire title Extent of the Use of E-Learning Facilities in the Teaching of Mathematics in Secondary School Questionnaire (EUEFTMSSQ). This questionnaire was designed in a four rating scales (VHE, HE, LE and VLE) and sent to two lecturers. One from the Department of Mathematics/ Computer Science and another from the Department of Education, Federal College of Education (Technical), Asaba for face and content validation. A test-re-test was carried out with 30 respondent (10% of the sample) from different locations to determine the reliability of the instrument. The co-efficient of reliability was 0.78 after Pearson's Product Moment Correlation Coefficient was used for the test. The data collected were analyzed using mean and standard deviation.

Results

Research Question One: To what extent does teacher uses e-learning software facilities in the secondary school to teach mathematics topics in Oshimili South Local Government Area of Delta State.?

Table 1: Mean and Standard Deviation of Respondents to Research Question One

S/N	Items	Mean	SD	Remark
1.	Using of data base package enhance the teaching and learning of Mathematics	3.42	0.37	High extent
2.	Using of power-point package for teaching presentation enhance the teaching and learning of Mathematics	2.02	0.41	Low extent
3.	Ability to use e-mail resources to help in the individualization of instruction	2.34	0,61	Low extent
4.	Ability to use word processing package	3.25	0.43	High extent
5.	Using of spreadsheet package for instruction (Excel) enhance the teaching and learning of Mathematics	1.67	0.38	Low extent
6	Using PDF software to open PDF document enhance the teaching and learning of Mathematics	2.52	0.44	High extent
7	Knowledge of software like Mavia, beacon enhance the teaching and learning of Mathematics	1.25	0.39	Low extent
Grand mean and SD		2.17	0.43	Low extent

Based on the grand mean score which is 2.17, it went further to show that very few of the teachers make use of software facilities while the others do not make use of software facilities in the teaching of mathematics topics.

Research Question 2: To what extent does teacher uses computer projector as teaching tools in teaching of mathematics topics in Oshimili South Local Government Area of Delta State.?

Table 2: Mean and Standard Deviation of Respondents to Research Question Two

S/N	Items	Mean	SD	Remark
1.	Using projector reduces time wasting by writing on chalkboard	2.34	0.36	Low extent
2.	Effectively use of projector makes teaching and learning more interesting	2.57	0.46	High extent
3.	The use of screen freeze feature to revise lesson taught enhance the teaching and learning of Mathematics	2.05	0.38	Low extent
4.	Using projector makes teaching process more organized	1.82	0.43	Low extent
5.	Using projector for presentation enhances teaching process	2.18	0.37	Low extent
6.	Using projector to display texts, images and video enhancing teaching and learning of mathematics	2.20	0.35	Low extent
7.	Using projector help to share notes digitally during teaching and learning	2.42	0.40	Low extent
Grand mean and SD		2.23	0.39	

The grand mean score of 2.23 which indicates that the teachers hardly make use of projector as a teaching tool in teaching and learning mathematics in the school

Research Question Three: To what extent do mathematics teachers have knowledge of e-learning hardware facilities as teaching tools in teaching mathematics topics in Oshimili South Local Government Area of Delta State.?

S/N	Items	Mean	SD	Remarks
1.	Ability to use flash drive for storing instructional materials	3.05	0.32	High extent
2.	Ability to use interactive whiteboards to deliver lectures to mathematics students	2.02	0.43	Low extent
3.	Using video recorders for recording teaching activities in the classroom	2.75	0.48	High extent
4.	Using laptop computer enhance the teaching and learning of Mathematics	3.35	0.49	High extent
5.	The use CD-ROM, Flash drives containing prepared lesson materials for teaching enhance the teaching and learning of Mathematics	1.25	0.42	Low extent
6.	Using electronic board and projector in enhancing learning of mathematics	1.83	0.42	Low extent
7.	Knowledge of computer simulation in teaching and learning of mathematics. enhance the teaching and learning of Mathematics	2.78	0.36	High extent
Grand mean and SD		2.43	0.42	

The grand mean of the distribution above was 2.43 which shows that the secondary teachers hardly make use of e-learning hardware facilities as a teaching tool in teaching of mathematics

Discussion of the Result

The findings from table 1 research question one revealed that the secondary teachers hardly utilize e-learning software in teaching and learning of mathematics topics. Based on the grand mean of 2.17 which indicates very low extent. The findings from table 2 research question two revealed that secondary schools teachers hardly make use of projector slide and others in teaching their students, mathematics and this make most students not to have knowledge on how projector look likes or how it works. The finding from table three research question three revealed that secondary school teachers, find it difficult to use e-learning hardware facilities as a teaching tool in teaching and learning of mathematics topics based on the grand mean of 2.40 which indicates low extent, which is contrary to Abe and Gbenro (2014), who observed that public secondary schools mathematics teachers hardly or rather use e-learning facilities in the teaching of mathematics topics.

Conclusion

This paper looked into how effective teachers in secondary schools has knowledge of ICT in teaching of mathematics topics and it was observed that teachers hardly or often use e-learning facilities in the teaching of the subject and that some of them have little or no knowledge of the internet facilities. However, there is the need to improve on the use of e-learning facilities not only that but also the use of e-learning brings a new mix of professional and instructional knowledge advantages to teachers, but is also consistent with the modern education life and global practice.

Recommendation

Based on the findings of the study, it was recommended that:

- i. School authorities should collaborate with government to ensure workshops for the teachers in secondary school so as to enable them to meet up with the current trend in the use of e-learning in teaching and learning
- ii. Modern facilities like laptops, computers desktop, computer projector and so on should be made available for teachers of mathematics and other subjects for the teaching in secondary.
- iii. Also, the school authority should try to invite some expert in the e-learning teaching to come and train teachers in their various schools.

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Mathematics: An Inevitable Instrument for Sustainable Development of Science and Technology in Nigeria

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Abstract

Without mathematics, meaningful sustainable development in science and technology cannot be achieved by any nation. Mathematics, Science and technology are in a symbiotic association, that is, technology depends on science, and science depends on mathematics. This paper x-rayed mathematics as an inevitable instrument for sustainable development of science and technology in Nigeria. The concepts of mathematics, Science and Technology were highlighted. Also, the relationships between mathematics and science, as well as mathematics and Technology were highlighted. In the same vein, sustainable development was briefly explained. The relationship of mathematics, science, technology and sustainable development was discussed. Recommendations to ensuring sustainable development of science and technology were advanced, among which include: adequate supply of instructional materials for the teaching and learning of mathematics and science subjects, special incentives for mathematics and science teachers, scholarship to outstanding performing students in mathematics and science subjects and encouragement of mathematics, science and technology clubs in schools.

Keywords: *Mathematics, Science, Technology, Sustainable Development*

Introduction

There is no human endeavor that is devoid of mathematics. The role it plays in the understanding of the structure of science and technology cannot be overemphasized. It plays a pivotal role in the Sustainable Development of science and Technology in Nigeria. It has been so useful right from the origin of man on earth. The early man was able to know, among other things, the number of animals he has, measure his land boundary, count the number of seeds to plant, and determine which season to engage in any activity. Onoshakpokaiye (2006), posits that mathematics is the most useful and fascinating divisions of human knowledge because man sleeps and wakes up with it.

Mathematics, science and technology are in a symbiotic relationship just as they are intimately connected. As an inevitable instrument, mathematics provides the foundational framework upon which scientific and technological advancement thrive. With its ability to solve complex problems, model real-world phenomena and enhance critical thinking skills, it is essential for driving innovations, fostering



economic growth, and addressing societal problems. It is evident, therefore that without a sound knowledge of mathematics, no one can effectively study science, hence, there can never be technological development. However, the subject has not received the attention it deserves. This is because of the low number of students who apply to study the course at higher levels of education, lack of adequate instructional materials for teaching the subject, absence of demonstration and construction laboratories for mathematics in schools, lack of support to outstanding students and committed science and mathematics teachers, as well as leakages that enhances corruption that deter sustainability of good policies that encourages the development of science and technology in Nigeria. It is against this backdrop that this paper seeks to draw the attention of stake holders in the field of science and technology that, for any meaningful sustainable development of science and technology, mathematics remains an inevitable instrument.

What then, is mathematics, science, technology and sustainable development?

What is Mathematics?

As there are many mathematicians so are the perspectives given to it. For instance, Umakalu (2016) identified mathematics as “the ingredient for effective articulation of the abstract elements of science that gives impetus to the development of technologies”. This perspective indicates that mathematics gives birth to science and science gives birth to technology. Also, Oyediji (2000), described mathematics as a creative language, a tool, an act, and a process. In the same vein, Onyeneho (2013) described mathematics as a human invention, born out of human resolves to solve human problems. Odili (2006) described mathematics as 'the science of quality and space'. That is, it is a creation of the human mind concerned primarily with ideas, processes and reasoning. Mathematics can also be seen as a body of knowledge, a collection of techniques and methods, the product of human activity towards solving human problems.

What is Science?

Lobo, Pietriga and Appert (2015) asserts that, Science is an organized body of knowledge about the universe, the aspect that touches our immediate existence. It can be described as observing, measuring, classifying, questioning, predicting, testing, experimenting and discovering to expand the knowledge about our immediate and remote environment (Awotunde & Ugodulunwa, 2004). They also posit that science can be described to involve the skills of observations, hypothesizing, experimentation and application of such skills to daily living. In the same vein, Atkins (2020) described science as 'the systematic study of the structure and behavior of the physical and natural world through observation and experimentation, based on evidence, reason and logic' Also, Karl(2017) defines



science as 'a systematic process of testing hypotheses against empirical evidence, with the aim of producing general theories that can explain and predict events in the natural world'. Science can be seen as a process that deals with man's understanding of the real world in relation to how he solves his problems.

What is Technology?

Manklik (2015) defines technology as 'the use of scientific knowledge for practical purposes or application, whether in industry or in our everyday lives. It includes everything from the wheel to computer, to medicines, to zippers and buttons on clothes'. He added that, technology involves the application of scientific knowledge in order to create tools and processes that may be used to change the world by increasing efficiency in nearly every aspect of our lives'. Technology can be described as a rational problem-solving approach and a systematic way of thinking. It can also be seen as the systematic application of organized knowledge, tools and materials for the extension of human faculties thereby increasing production, distribution of food, better roads, health facilities, comfortable accommodations, among others, with a sustainable plan.

What is Sustainable Development?

Evers (2018) described sustainable development as the organizing principle for meeting human development goals while at the same time sustaining the ability of natural systems to provide the national resources and ecosystem services upon which the economy and society depend. Considering it from this perspective, sustainable development aims at achieving social progress, environmental equilibrium and economic growth. Ben-Eli (2015) wrote that "sustainable development entails producing more and better food to eat, healthier and happier individuals, better living accommodations, improved transportation system and improve communication system". This cannot be achieved without science and technology which are dependent on mathematics.

Mohieldin (2017) argued that sustainable development rests, fundamentally on: economic sustainability, which has to do with a system of production that satisfies present consumption levels without compromising future needs; social sustainability, which has to do with notions of equity, empowerment, accessibility, participation, cultural identity and institutional stability; and environmental sustainability; which has to do with the natural environment and how it remains productive and resilient to support human life. It can also be said that sustainable development emphasizes a positive transformation trajectory anchored essentially on social, economic and environmental factors which include: economic growth, environmental protection and social equality.



Relationship between Mathematics and Science

Mathematics, apart from being an intellectually stimulating discipline is continuously being developed to meet the changing requirements of science. Achievement in science is contingent upon mathematical knowledge and the ability to perform mathematical operations. For instance, in physics, the important objective of a first course in mechanics is to train students to view phenomena and this requires a sound knowledge of elementary differential equations and vector analysis. Also, complex numbers are used in treating oscillation quantities and on the principle of super position. In the same vein, to describe the motions in a plane or space, the physicist must have a good understanding of vector algebra. Again, in any section of physics, optics, electricity or thermodynamics, mathematics forms the basis for understanding it and also its application (Odili, 2006).

Another instance is in chemistry where understanding topics such as fractions, decimals, scales, line graph, addition and subtraction of logarithm numbers, ratio and proportions, indices, direct and inverse proportions, substitution of values in an algebraic expression, change of subject of formula, among others, are inevitable (Ahiakwo, 2013). He also posits that at higher level, a good knowledge of calculus is necessary in the study of chemical thermodynamics, chemical kinetics and the laws of mass action. In the Biological sciences, Akinbuwa (2001) gives mathematical techniques and methods that are closely interlinked with biological work to include: cell growth, enzymatic reactions, physiological tracers, biological fluid and diffusion, all of which follow a course in elementary differential equations, linear algebra and graph theory. Also, methods of calculus are used to explain the growth of micro-organisms.

In medicine, the conduct of electronic signals by nerves, flow of blood, calculations of radiation, treatment of patients and diffusion of radioactive tracers and other chemicals in the body are tackled using mathematics (Adetula, 2002). He further posits that from a minor surgery of ulcer to a major brain surgery or organ transplant, mathematics has a place with regards to precision of measurement. In agriculture, mathematics enables us to determine the acidity and alkalinity of a soil which helps the farmer to determine whether the soil is suitable for a particular crop or not. From the foregoing, it is not debatable that there can never be science without mathematics.

Relationship between Mathematics and Technology

There have been major developments in technology in more recent years of which information and communication technology is outstanding. Its effectiveness as an instrument of information dissemination is not inherent in its transmitted form, but its power is derived from the mathematical machine that converts inputs into outputs. Aminu (2005) asserts that, In the aircraft technology for instance, mathematics have dominated the scene in all aspects of its development especially by way of research in aeronautics and in the structure of the aircraft itself. The branch of mathematics that

is mostly associated with aeronautics is fluid dynamics, which is the study of motion of gases and liquids that involves the use of Eulerian equations of motions of fluids together with the continuity equation, which expresses the conservation of mass and the equation of the state of the fluid. All the mathematical results obtained from the solutions of these equations lead to decisions on viscosity of the air, the steadiness of the motion of the aero plane, external forces acting on the body of the aero plane, the condition of the air and state of the flow of air. He added that the development of the aircraft industry and air traffic has largely relied on the use of electronic digital computer which is a branch of mathematics. It can therefore be said that the knowledge and application of mathematics forms the basis for technological advancement, hence, mathematics and technology are inseparable if there must be sustainable development of technology in Nigeria.

Relationship between Mathematics Science, Technology and Sustainable Development

Agha (2003) described the relationship between mathematics, science and technology as “basic family unit comprising the father, the mother and the child”. He also said “if the three are healthy and there is a normal streamlined, functional relationship within the family, there is a high level of economic, social and political development to the benefit of each all, the family grows”. In the same vein, Ekhuagere (2007) posits that “A nation economy, on one hand, and its science and technology on the other hand are Siamese twins sharing a common heart called mathematics. Destroy the heart and you destroy the twins; fatally injure one of the twins and you fatally injured the other as well as the heart itself. There is therefore a fundamental responsibility on the nation to keep the heart in a healthy state at all times'. The implication of the above statement is that, mathematics, science, and technologies as well as sustainable development are inseparable. There cannot be sustainable development in technology without science and there cannot be sustainable development in science without mathematics. They must all come together for a nation to develop. There is no country or nation in the world that can experience or has experienced meaningful sustainable growth and development without technology, and mathematics is the foundation of science which brings about technology. It can, therefore be said that, it is practically impossible to experience scientific and technological development that is sustainable without giving proper attention to the effective teaching and learning of mathematics.

Conclusion

For any nation to experience any meaningful sustainable development in science and technology, the teaching of mathematics must take its rightful stage at all levels of education. The role mathematics play in actualizing sustainable development of science and technology cannot be over emphasized. This explained why mathematics, science and technology are in a symbiotic association, that is, technology depends on science and science depends on mathematics.



Recommendations for Sustainable Development of Science and Technology in Nigeria

Firstly, following the few number of students that apply to study mathematics in Nigerian higher institutions, there is urgent need to encourage more students to study the subject. This could be done through orientation programs organized for pupils and students where the importance of mathematics as the only gate to science and technology are emphasized.

Secondly, there is the urgent need for government at all levels to initiate, sponsor and supervise regular seminars, workshops and in-service courses to keep mathematics and science teachers updated on new trends in mathematics and science subjects.

Thirdly, mathematics, Science and Technology clubs should be encouraged. They should be patronized during exhibition days to boost their morale. Also, public lectures by well-known mathematicians and scientist should always be organized so as to motivate students to be committed to the tasks of invention.

Fourthly, there should be adequate supply of instructional materials for the teaching and learning of mathematics and science subjects. Schools should be provided with well-equipped Construction and Demonstration Mathematics Laboratories as well as well-equipped Science and Technology Laboratories.

Fifth, mathematics and Science teachers should be given special allowances to encourage them to embark on in-depth research for new innovations and inventions to boost scientific and technological advancement. Sixth, government should make deliberate effort to close leakages that enhances corruption that may deter the sustainability of good policies that encourages the development of science and technology in Nigeria.

Seventh, scholarship should be given to students with outstanding performance in mathematics and science skills by individuals or non-governmental organizations so as to maximize their potentials.

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Promoting Science and Technology Based Learning through the Utilization of Extended Reality in Teaching and Learning of Practical in Tertiary Institutions in Nigeria for Sustainable Development: A Case Study of Federal College of Education (Technical), Asaba.

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Abstract

The transformation capabilities of Extended Reality cannot be overemphasized. In this 21st century, a lot of strategizing have been done, theories propounded, etc by major stakeholders in the education sector and other sectors in order to improve education to forestall sustainable development in the area of education. All these efforts seem to only influence unnoticeable changes; hence this research work. This study was carried out to ascertain the adoption and utilization of extended reality in teaching and learning in Federal College of Education (Technical) Asaba, Delta State. A descriptive survey research design was adopted for the study. Four research questions guided the conduct of the study. The population of the study comprised all the 1400 students in Federal College of Education (Technical) Asaba, Delta State while the sample of the study consisted of 140 students. The random sampling technique was employed to select the students. The instrument used for data collection is a structured questionnaire, which was structured by the researchers. One hundred and forty (140) copies of the validated questionnaires were administered on the selected students by the researchers with the help of two research assistance out of which 135 were retrieved and analysed using mean statistics. Findings of the study revealed amongst others that gadgets are available for effective utilization of extended reality in teaching and learning practical but they have not been adopted and effectively utilized in Federal College of Education (Technical) Asaba, Delta State due to factors such as, lack of training, poor electricity supply and poor internet connectivity, etc. The study recommended amongst others that there should be constant electricity supply and strong internet connectivity to enhance the utilization of extended reality in teaching in the college.

Keywords: Extended Reality, Virtual Reality, Mixed Reality, Augmented reality, Gadgets, Sustainable Development,

Introduction

The world has become a global village and access to information is easier and faster than ever before. This is due to the development of information and communication



technologies. It also makes learning easier and more comfortable. Today, students can study and interact with teachers from the comfort of their homes. Today, education is delivered through a different medium called Extended Reality (XR). Extended Reality is an umbrella term for Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), all of which involve using a device to present interactive information or representation of virtual information in a 3 Dimension capacity (Roy, 2019). Extended reality is a simple term used to describe new technologies such as virtual reality and augmented reality. Technologies that continue to be developed and used rapidly in fields such as education and business will change digital communication and human relations in the next decade. It is an effective learning process that enables users to gain unique knowledge that cannot be obtained otherwise.

Extended Reality provides a "hands-on" experience, facilitating student engagement with the curriculum and increasing student engagement with complex problems (Pomerantz, 2019) immersive of Extended Reality (XR) has been shown to improve performance standards and Pedagogy. (Brown, 2020). XR education has grown in higher education over the past few years as a specialized field of study and helps students acquire the knowledge and skills they need. Research has shown a link between the use of XR technology and improvements in student learning and motivation, student relationships and collaboration, and student thinking and skills. With the move to online models, XR technology can help bridge the gap between in-person and online classrooms and create space for more opportunities for collaboration and presence. However, research on its application in higher education is still lacking (Radianti, Majchrzak, Fromm & Wohlgenannt, 2020). With the latest developments in XR technology, ease of use, effective education and low cost, the use of XR technology as a learning tool is one of the most important innovation and research areas in many universities (Pomeranz, 2019).

XR technology provides students with unique learning experiences that may not be possible with traditional learning methods. Augmented reality in educational settings enables students to learn like never before. One can teach kindergarten students about the sun or show high school students the human body, all of which prepare medical students to perform life-saving surgeries. This ability to relate to real-life situations provides long-term reality benefits beyond its limited capabilities. Obviously, one cannot send a class of students on a trip to the moon for the first time. At least of course. With a simple VR simulation, they can start exploring the solar system in seconds. The potential of augmented reality as a learning tool attracts researchers from different disciplines. Augmented reality in learning offers students a way to enhance their learning with 3D graphics and beautiful graphics. It is



revolutionizing education with the use of educational technology that enables students to learn faster and better and retain information for longer. Delivering virtual reality in education can provide a fun and engaging learning experience for students and teachers! Technology continues to use the human-machine interface and change it by firstly immersing one in a virtual environment and secondly adding or supplementing the user environment (Pomerantz, 2019) is used by smart devices to create a series of lessons and appropriate content above the user's physical environment, providing students with interactive and educational benefits creates an all-digital environment, a 360-degree, immersive user experience that feels realistic.

In a VR environment, students can interact with what they see as if they were there. Students today use Augmented Reality and Virtual Reality to accelerate learning by more effectively animating and visualizing learning materials in a safe environment. To bridge the gap between theory and practice, the interactive 3D environment allows students to collaborate and learn from each other, making memories a more inclusive and collaborative learning experience. Augmented reality offers incredible experiences to expand the learning environment from primary education to further education. It actually allows students to learn like never before. It can teach kindergarteners about the sun, show high school students the human body, and help medical students perform life-saving surgeries. Extended reality encourages participation. This new technology makes learning fun and allows students to apply what they have learned in a safe environment. Distance education is nothing new, it continues to take it further. Today, students can take virtual classes and online classes from the comfort of their homes. They can also choose their own time by arranging a study that fits a certain time each day (Robertson, 2020). All this makes learning cheaper, faster and more efficient. Augmented reality makes it easy to understand complex concepts through interaction, interactive visualization and 3D graphics, so students can study Biology, Chemistry, Mathematics, etc. It has the potential to help them better understand the issues. For example, if students have trouble understanding Chemistry, looking at compounds such as acids and oxides in 3D images and interacting with their shapes and uses can help students see and understand these concepts clearly. No two students are created equal, but traditional teaching methods often use a positive approach to learning. Students understand and retain better when classrooms use a continuous learning process using realistic technologies such as virtual reality.

Augmented reality with visualization and 3D graphics helps students stay focused while learning. This is because visualizations and 3D images are interactive images that engage students' multiple senses and make learning fun. That's why AR helps students get involved because it helps motivate them and build their confidence. More details can be used to improve student learning and engagement (Philipson,



2018). Augmented reality learning can change the way learning content is presented; works on the site to create a virtual world (real or imagined) and allows users to see and interact with it. Immersion in what has been learned allows students to understand what has been learned. Augmented reality can work as an assistive technology for students with disabilities as it can reduce the impact of disability and offer an alternative way of performing activities (Pomerantz, 2019). Augmentative technology such as virtual reality is an inclusive tool; VR collaboration can help students with disabilities. Students who are normally isolated from their peers can join them well. This relationship can increase self-esteem and academic achievement. Teacher Empowerment enables students to learn quickly, anytime, anywhere with the right technology, and easily search and understand complex content with relevant classroom information. Learn to follow the curriculum and STEM guidelines for immersive content. With augmented reality, we can connect distance learners to a virtual environment designed to create a physical classroom or let them travel in an environment where they cannot visit themselves. Before the pandemic, education was often seen as the domain of new technology.

The use of new technology and innovation is a costly and time-consuming process for schools, colleges and universities. It is often easier for teachers to maintain traditional teaching than to enter a new environment (Kinsley, 2019). Rapid changes in the world of continuous reality, coupled with investments in educational solutions, are leading to the rapid growth of continuing education. The device is used to combine or mirror the physical world into a "digital twin" that can interact with each other. Virtual reality and augmented reality businesses have grown rapidly and are used in many ways, including entertainment, business, real estate, education and remote work. Augmented reality education includes learning technologies: virtual reality, augmented reality and mixed reality. This type of education "expands" reality by moving the student into a safe, multidisciplinary learning environment that mimics real-world educational situations. Colleges and universities have access to instructional technology today, especially in developing countries. Some developing countries in Africa have also adopted this new technology called augmented reality. But it is unclear whether Nigerian tertiary institutions have adopted the same practice. Therefore, there is a need to examine the adoption and use of augmented reality in teaching and practice at the Federal College of Education (Technical) Asaba. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Purpose of Study

The main purpose of this study is to identify the adoption and use of Extended Reality in teaching and learning at the Federal College of Education (Technical) Asaba, Delta State. Specifically, this work was categorized as follows:



1. The level of useful materials used in the teaching and practice of the Federal College of Education (Technical) Asaba.
2. Whether Augmented Reality is effectively used in teaching and learning at Federal College of Education (Technical) Asaba.
3. Factors related to the use of Virtual reality in teaching and practice in Federal College of Education (Technical) Asaba
4. Strategies for Capacity Building in Teaching and Learning in Federal College of Education (Technical) Asaba

Research Questions

The research questions guiding this study are:

1. How many devices are available at Federal College of Education (Technical) Asaba to effectively use augmented reality in real-world teaching and learning?
2. Is extended reality being used in teaching and learning with some practical effectiveness in Federal College of Education (Technical) Asaba?
3. What factors influence the use of augmented reality in teaching and practice in Federal College of Education (Technical) Asaba?
4. What are Federal College of Education (Technical) Asaba's strategies for improving the effectiveness of the use of augmented reality in teaching and learning in practice?

Gadgets for the Effective Utilization of Extended Reality in Teaching and Learning Practical

Extended Reality (XR) is a term that refers to the combination of real and virtual environments using computer technology, including Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR). These engineering tools According to Austin (2019) can greatly enhance the student learning experience:

AR users experience the real world with an overlay of computer-generated digital information.

AR devices include the Microsoft HoloLens, Google ARCore and Apple ARKit. VR immerses a user in an entirely simulated environment that shuts out the physical world. With VR devices like the HTC VIVE, Oculus Rift or Google Cardboard, users can look around the artificial world, move around in it, and interact with virtual features or items. MR is the merging of real and virtual environments, and with tools like the Microsoft HoloLens, users can interact with both physical and digital objects in real space. From overhead projectors and blackboards to SMART boards, computers and tablets, the devices used for teaching and learning are changing as new technologies are being developed.



Utilization of Extended Reality in Teaching and Learning Practical

Extended reality in teaching is a new concept especially in developing countries. As the full potential of technology is continuously being unfolded and students today are more attracted to using technology, institutions that accept and encourage such use in the classroom could boost student creativity and inspire new ideas.

Recent advances in technology, such as extended reality, can give students in various disciplines more opportunities to expand and grow their creativity and innovation in education in new and different ways.

Using these technologies can help students as well as teachers to think outside the box and into a new, interdisciplinary mode.

Incorporating new tech into the classroom rather than resisting it is essential for inspiration and can contribute greatly in the long run.

Extended reality technologies can provide a new way of solving some of the problems of conventional education and can be more effective for teacher-centered teaching as opposed to the traditional way of teaching through lectures and presentations on a screen or paper.

Implementing virtual reality (VR), augmented reality (AR) and mixed reality (MR) technologies in the classroom can give students exciting and new experiences they won't soon forget.

VR and AR lessons designed for students of all ages can help increase classroom engagement and improve comprehension.

By delivering engaging graphics, 360-degree experiences, simulations and more, students can understand concepts by experiencing rather than just reading as they immerse themselves in lessons. While the world of VR and AR is not new, the technologies have mostly been functional in the creative and gaming industries. However, they can serve the education sector (as well as other industries) with a different spin. AR's ability to superimpose virtual enhancements on real-world objects and MR's ability to simplify complex concepts or theories without the use of such intricate machinery in-house can be extremely useful in the education sector.

In complex fields such as aerospace engineering, extended reality technologies can enable 3D models to be developed for students to explore and learn in-depth, as they are able to dismantle parts of airplanes and interact with them using their own hands or even stop the airplane to understand its aerodynamics (Abhinand, 2020). However, empirical research on its applications in higher education is still inadequate (Radianti, Majchrzak, Fromm & Wohlgenannt, 2020). With the recent development, the ease of use, the proven dramatic impact on pedagogy and the noticeably decreased cost of the XR equipment, implementing XR technologies as learning tools becomes one of the most active fields of innovation and research among the various

higher education institutions (Pomerantz, 2019). XR technologies offer learners a unique learning experience that may be unattainable in a traditional educational format. VR, AR and MR have the potential to transform the way we interact with day-to-day aspects, across a wide range of industries. And combined, as XR technology, this will be equally transformative for both students and teachers.

According to Gilbert (2020), extended reality:

Allows for safe experiential learning

XR training creates a safe training space for experiential learning where learners can practice taking risks and learn from their mistakes.

Realistic hard and soft skills practice.

With XR technology, learners can develop their hard skills (e.g. operating and repairing equipment) and soft skills (e.g. communication and empathy) through realistic interactions with people and equipment.

Convenient to scale and reuse

With an XRS and additional access options, schools can conveniently scale their XR training across their school and reuse content as much as needed.

To sum it all up, by using extended reality (XR), people are able to visit virtual environments and engage in experiences in an immersive and interactive way that can realistically match what they can access in the real world.

Factors Affecting the Utilization of Extended Reality in Teaching and Learning

To be adopted, an innovation must be compatible with whatever existing systems are in place. And to be adopted not just by one instructor but more widely, across a curriculum or a field, an XR application must fit into existing instructional methods. Many disciplines have existing standards, or at a minimum existing curricula and instructional methods (as in Biology), and XR must fit into such existing standards and practices. Over time, these standards and practices will change, at least in part due to the impact of XR. But, at least initially, innovation must align with existing ways of working.

As with any innovation, it has its own set of challenges, and augmented reality is no exception. According to Obed (2018), the following factors influence the adoption of augmented reality in higher education institutions in Nigeria:

1. **Cost:** The devices required for augmented reality in education are very expensive and many educational institutions in the country cannot afford to purchase them due to lack of financial resources. This has prevented full acceptance of the idea of augmented reality in education.
2. **Lack of Expertise.** Augmented reality in education requires a high level of skill that many teachers lack. Many teachers do not have a working

- knowledge of augmented reality in education, making it difficult to implement in higher education institutions in Nigeria.
3. **Poor Power Supply:** Augmented reality in education relies on power supply, which is a big problem in our country, Nigeria. Poor power supply has prevented many higher education institutions from adopting augmented **reality in education and other e-learning platforms.**
 4. **Bad Service Culture:** The system should work effectively and there should be a good and efficient service culture for many years to come. But in our country it is the other way around. After spending a lot of money to buy an augmented reality device, maintenance becomes an issue because these materials can be wasted and difficult to use.
 5. **Educators Attitudes:** Nigeria is considered one of the countries that have difficulty adapting to change. This is because people are too accustomed to the old ways to accept change. This is one of the problems or challenges facing the effective use of extended reality in education.
 6. **Lack of Training:** Implementing a new system in any field requires training and retraining of those who can use it. But in Nigeria, the opposite is true because educators are not trained to use augmented reality in education, making it difficult to embrace.
 7. **Hardware Problems:** Interfaces required to access advanced technologies, devices, and interfaces still face many challenges in accurately rendering visuals. Improvements can be expected as related technologies such as 5G and edge computing also evolve, helping to make XR more complex.
 8. **Scepticism:** This technology has not yet gained a large audience as many consumers have not yet realized the benefits and wide range of applications of this technology. There is also a general lack of clarity around issues such as data privacy and security that may affect consumers' minds when deciding whether to experiment with augmented reality technology.
 9. **Connectivity:** Few things break the magic of an immersive experience like an unreliable connection. Technical connectivity issues are another challenge facing the field of augmented reality.

Strategies for Enhancing Extended Reality in Education and Practice

To use extended reality effectively in education, you need to do a few things right. According to Gilbert (2020), extended reality can be used in higher education institutions if:

1. **Teaching and Retraining:** Augmented reality in education requires a high level of skill that many teachers lack. Educational institutions should structure training programs to ensure that instructors have the necessary skills to effectively use augmented reality in education.

2. **Permanent Power Supply:** Augmented reality in education relies on power supply, which is a big problem in our country, Nigeria. The effectiveness of augmented reality in education requires governments to continuously electrify the country's higher education institutions.
3. **Good Service Culture:** The system should work effectively and there should be a good and efficient service culture for many years to come. Management of educational institutions must ensure regular maintenance of devices used to improve the effectiveness of augmented reality use in education.
4. **Acceptance:** Both teachers and students need to recognize that augmented reality education needs to be fully embraced in higher education institutions.
5. **Improved Communication.** Because augmented reality in education depends on the full functionality of the network, educational institutions must ensure that the network can be used to effectively use augmented reality in teaching and learning.
6. **Provision of Devices:** Governments must provide the necessary materials to make augmented reality a reality in education and learning. If the above and more are put into consideration, extended reality in teaching and learning in Nigerian higher institutions will be a reality.

Methodology

The study adopted a descriptive survey design. Descriptive survey design is one in which a group of people is studied by collecting and analysing data from only a few people considered to be a representative of the entire population (Robert, 2016). The study was carried out in Federal College of Education (Technical) Asaba, Delta State. It is located along the Asaba-Ibusa highway in Asaba, in Oshimili South Local Government Area of the Delta State. The College residents are primarily teachers, non-academic staff, students, and business people. The choice of educational institution was due to the fact that it trains future teachers who will teach the younger generation. The study population was made up of both NCE and Degree students of the Federal College of Education (Technical) Asaba. A total of one thousand, four hundred students. The study sample consisted of one hundred and forty (140) students. The random sampling technique was employed to select the students. The instrument used for data collection is a structured questionnaire, which was structured by the researcher titled "Utilization of Extended reality in teaching and Learning Practical Questionnaire (UERTLPQ)". The questionnaire had two sections; section "A" comprised of the respondent's personal data and section 'B' had the questionnaire items with their corresponding options. The questionnaire had four points scale which were coded and weighted as follows: SA- Strongly Agree (4), A- Agree (3), D- Disagree (2), SD- Strongly Disagree (1); VHE- Very High Extent (4), H- High Extent (3), LE- Low Extent (2) and VLE- Very Low Extent (1). One hundred

and forty (140) copies of the validated questionnaires were administered on the selected students Federal College of Education (Technical) Asaba, Delta State by the researchers with the help of two research assistance out of which 135 were retrieved and analysed. The method used in analysing the data collected is mean statistics. The bench mark is fixed at 2.50. Therefore, any item with the mean of 2.50 and above were considered Agree or high extent, while items with mean below 2.50 were considered Disagree or low extent.

Results

Research Question One: How many devices are available at Federal College of Education (Technical) Asaba to effectively use augmented reality in real-world teaching and learning?

Table 1: *Extent of the Availability of Gadgets for the Effective Utilization of Extended reality in teaching and Learning Practical in Federal College of Education (Technical) Asaba*

S/N	Statement	Mean	Decision
1.	Cameras are available for effective utilization of extended reality in teaching and learning of practical.	2.12	Low Extent
2.	Computers are available for effective utilization of extended reality in teaching and learning of practical.	3.12	High Extent
3.	Free WIFI connection is available to enhance effective utilization of extended reality in teaching and learning of practical.	2.99	High Extent
4.	Alternative source of power (solar, generator, etc) are available for effective utilization of extended reality in teaching and learning of practical.	2.91	High Extent
5.	Different kinds of applications are available for enhance effective utilization of extended reality in teaching and learning of practical.	2.04	Low Extent
Grand Mean		2.64	High Extent

Source: Researcher's Compilation, 2023

Table 1 shows that the response was high extent in items 2, 3 and 4 but low extent in items 1 and 5. This is because, the mean scores for items 2, 3 and 4 were significantly higher than 2.50 bench mark for determination of a value as high or low extent while the mean mark value for items 1 and 5 were significantly less than 2.50 benchmark. The grand mean of 2.64 revealed gadgets are available for the effective utilization of extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba.

Research Question Two: Is extended reality being used in teaching and learning with some practical effectiveness in Federal College of Education (Technical) Asaba?

Table 2: *Extent of the Effective Utilization of Extended reality in teaching and Learning Practical in Federal College of Education (Technical) Asaba.*

S/N	Statement	Mean	Decision
6.	Extended reality in teaching and learning of practical are utilized for teaching practical topics in biology education.	2.02	Low Extent
7.	Field Trip is utilized as extended reality in teaching and learning of practical	2.17	Low Extent
8.	Extended reality in teaching and learning of practical is utilized in teaching step-by-step problem-solving process.	2.00	Low Extent
9.	Extended reality in teaching and learning practical is used in teaching students the art of public presentation.	1.90	Low Extent
10.	Extended reality in teaching and learning practical is used enhance the competence of students in biology education.	1.80	Low Extent
Grand Mean		1.98	Low Extent

Source: *Researcher's Compilation, 2023*

Table 2 indicates that the response was low extent in items 6, 7, 8 and 9. This is because, the mean scores for all items in the table were significantly less than 2.50 bench mark for determination of a value as high or low extent. The grand mean of 1.98 revealed that extended reality in teaching and learning practical is not effectively utilized in Federal College of Education (Technical) Asaba.

Research Question Three: What factors influence the use of augmented reality in teaching and practice in Federal College of Education (Technical) Asaba?

Table 3: *Factors Affecting the Adoption and Utilization of Extended reality in teaching and Learning Practical in Federal College of Education (Technical) Asaba.*

S/N	Statement	Mean	Decision
11.	Unavailability of gadgets affects the use of extended reality in teaching and learning of practical.	2.81	High Extent
12.	Extended reality in teaching and learning of practical is affected by poor electricity supply	2.96	High Extent
13.	Non-challant attitude of educators impedes the use of extended reality in teaching and learning of practical.	3.16	High Extent
14.	Lack of training and re-training of educators on the use of extended reality in teaching and learning of practical adversely affects its utilization	3.24	High Extent
15.	Poor internet connectivity negatively affects the use of extended reality in teaching and learning of practical.	2.80	High Extent
Grand Mean		3.00	High Extent

Source: *Researcher's Compilation, 2023*

The analysis as presented in table 3 revealed that the response was high extent in items 11, 12, 13, 14 and 15. This is because, the mean scores for all items in the table

were significantly higher than 2.50 bench mark for determination of a value as high or low extent. The grand mean of 3.00 revealed that several factors affect the effective utilization of extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba.

Research Question Four: What are Federal College of Education (Technical) Asaba's strategies for improving the effectiveness of the use of augmented reality in teaching and learning in practice?

Table 4: *Strategies for Enhancing the Extended reality in teaching and Learning Practical in Federal College of Education (Technical) Asaba*

S/N	Statement	Mean	Decision
16.	The use of extended reality in teaching and learning of practical can be enhanced through constant training and re-training of educators.	2.88	High Extent
17.	Constant electricity supply would help to improve the use of extended reality in teaching and learning of practical.	2.93	High Extent
18.	The use of extended reality in teaching and learning of practical would be more effective if the needed gadgets are readily available	3.02	High Extent
19.	Improve internet connectivity can improve the use of extended reality in teaching and learning practical	3.10	High Extent
20.	Good attitude of educators towards the use of extended reality in teaching and learning of practical would make it acceptable.	2.64	High Extent
Grand Mean		2.91	High Extent

Source: Researcher's Compilation, 2023

Table 5 indicates that the response was high extent in items 15, 16, 17, 18, 19 and 20. This is because, the mean scores for all items in the table were significantly higher than 2.50 bench mark for determination of a value as high or low extent. The grand mean of 2.91 revealed that there are strategies for enhancing the effective utilization extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba.

Discussion of Results

Analysis of data shows that gadgets are partially available for the effective utilization of extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba. Study revealed that gadgets such as computers, alternative source of power and WIFI are available for effective utilization of effective utilization of extended reality in teaching and learning practical in the college. This is in agreement with Austin (2018) who asserted that there are tools for effective application of extended reality in teaching. On the effective utilization of extended reality in teaching and learning practical, the study revealed that extended reality in teaching

and learning practicals is not effectively utilized in Federal College of Education (Technical) Asaba. This is in line with Robert (2018) who found that extended reality in teaching has not been fully adopted due to certain factors such as hardware and software. Extended reality remains a new innovation in educational setting the its usage has not been fully embraced in most of our institutions of higher learning and Federal College of Education (Technical) Asaba in particular.

Analysis of data on the factors affecting the effective utilization of extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba, the study revealed that several factors affect the effective utilization of extended reality in teaching and learning practical in college. Factors such as unavailability of gadgets, poor electricity supply and others negatively affects the use of extended reality in teaching and learning of practical. This is supported by the findings of Olaniyi (2019) and Robert (2018) who found in their respective studies that many factors hinder the utilization of extended reality in teaching. Finally, on the strategies for enhancing the effective utilization extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba, the study indicated that there are strategies for enhancing the effective utilization extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba. Olaniyi (2019) and Robert (2018) also concluded that there are several ways through which the use of extended reality in teaching enhanced.

Conclusion

Extended reality in teaching and learning practical is no doubt a teaching method that brings the abstract into concrete reality thereby bridging the gap between theory and practical teaching. It goes just showing students what a concept is all about to making them experience the reality of what is being talked about. Based on the light of the above, the study hereby concludes that though there are certain gadgets available for the effective utilization of extended reality in teaching, it has not been effectively utilized in Federal College of Education (Technical) Asaba, Delta State which have been attributed to certain factors such as unavailability of gadgets, poor electricity supply, non-challans attitude of educators, lack of training and re training of educators and poor internet connectivity. The study also concludes that if certain strategies are adopted, the effective utilization of extended reality in teaching practical can be achieved in the study area.

Recommendations

On the basis of the findings, the researchers recommended that:

1. Gadgets should be made available by the Government to ensure the effective utilization of extended reality in teaching and learning practical in Federal College of Education (Technical) Asaba, Delta State.
2. Continues power supply should provided by the College management for effective use of augmented reality in teaching and practice.



3. The College management should organize educational programs to train teachers using augmented reality in teaching and learning to increase efficiency.
4. A stable internet connection should be made available to effectively use augmented reality for teaching and hands-on learning.

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Perceived Student's Perception on Factors Affecting Academic Performance in Mathematics at Senior Secondary Schools; Implications for Promoting Science and Technology for Sustainable National Development in Nigeria

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Abstract

The study aimed at examining student's perception on factors affecting academic performance in Mathematics at senior secondary school level in Oshimili South Local Government of Delta State. A descriptive survey design was adopted. The target population was all the senior secondary schools in Oshimili South Local Government of Delta State with a sample size of 180 students which is made up of twenty students each were randomly selected from each of the nine schools selected and a researcher's developed Students Perception Questionnaire (SPQ) was used for the study. Five research questions and two hypotheses were formulated to guide this study. The instrument was validated by experts and was subjected to reliability test which attained a reliability coefficient of 0.73 using the method of test-retest which was considered appropriate. The research questions were analyzed using mean and standard deviation, while the research hypotheses were tested using t-test statistics at 0.05 level of significance. The findings from the study revealed that students' perceived lack of communication skills and teaching method on the part of mathematics teachers, inadequate Mathematical laboratory facilities/instructional materials, high level of mathematical anxiety among others were identified as contributory factors hindering academic performance in mathematics. Recommendation proffered for remedy include: That stakeholder in education should provide well equipped mathematical laboratory, provision of functional counseling unit, appropriate textbooks and using of learner center approach. In conclusion, the study urged all stakeholders in education in mathematics education to ensure adequate provision of fund and facilities to all the secondary schools in order to minimize the rate of failure in Mathematics.

Keywords: Academic performance, Mathematics anxiety, students' perception, Science and Technology



Introduction

Education is regarded as the back bone of any national development; no nation can develop above her educational quality. The way Mathematics concepts are developed and taught will go a long way in helping students to improve on their understanding of both concepts and application in life. Mathematics is very important subject. It is the tool for understanding science, technology and business so it is a force to be reckoned with in the development of any nation and generally been accepted as foundation of science and technology (Okeke, 2019). Also Ashcraft and Kirk (2019) indicated that Mathematics is the language of science and foundation of rational development and productivity. To attain self-reliance and economic development, maximum premium must be placed on science and Mathematics. This led the federal government of Nigeria to make Mathematics one of the core subjects with the following objectives: as to develop interest in Mathematics and provide a solid foundation for everyday life. Also to develop computational skills, foster the desired ability of accuracy to a degree relevant to the problem at hand and develop necessary background for further education [National Policy on Education (N.P.E, 2004)].

Cassidy (2014) and Joy (2014) have indicated that perception is the process by which one becomes aware of changes through the senses, sight, hearing etc. Perception of mathematics by students may be to refer to the analyzing, synthesizing and integration of sensory information about mathematics concepts. For effective teaching, school principals and teachers require information as to the causes of poor academic performance in each subjects and mathematics. This information would assist on approach to improve understanding of students in mathematics (Yolanda, 2021). Mathematics has always been perceived as the most difficult subject in the school curriculum. Students continue to record high rate of failure in mathematics as reported by (Ajani & Papoola, 2019). A number of scholars outlined some factors they considered to be responsible to this trend on both internal and external examinations (Ebele & Abigail, 2018; Ajani & Papoola, 2019). These factors include:

Dissatisfaction with the syllabus; Experience and disposition on the part of students; Lack of appropriate mathematics textbooks; Lack of mathematical laboratory and its facilities; Mathematics teachers' attitude to work; Teachers students' relationship; Mathematics anxiety in teaching and learning mathematics; Students' previous experiences/knowledge of instruction. Ajani and Popoola (2019) had reported high rate of failure in secondary school mathematics. The decay in the standard of education has made many mathematics educators concerned about contributed factors. It was reported by Ashcraft and Kirk (2019) that mathematics anxiety is negatively correlated with mathematics performance among teachers and students. Mathematics students with mathematics anxiety possess little or no confidence in

their ability to solve mathematics problems. The correlation between mathematics anxiety and academic performance among students and teachers is negatively significant (Ajani & Papoola, 2019). The benefit of having a positive attitude towards mathematics cannot be over emphasized, because an individual's influences not any how circumstances, and the action of the others are interpreted by individuals (Garba, 2023).

Teacher's attitudes are very important act in teaching process because their attitudes can influence teaching strategies, which in turn have critical effect on the formation of student's attitude towards learning. They listed some characteristics of mathematics anxiety that include uneasiness when asked to perform mathematically, avoidance of mathematics classes, feeling of physical illness, panic, inability to perform on a test and utilization of tutoring sessions that provide very little success. Mathematics anxiety is found on both teachers and students which resulted to negative attitude towards mathematics and this attitude seems to have passed from one generation to the next-up today (Ajani & Popoola, 2019). In the area of teaching and communication skill of mathematics, Kajuru and Popoola (2019) observed that effective communication skills involves the ability to deliver or teach mathematics with simple language, easy to understand presentation, appropriate and effective teaching aids. Provision of effective communication improves the academic performance of students, thereby motivating them to score high marks (Garba, 2023).

Similarly, a number of studies revealed that performance of students in mathematics has been persistently low and attributed the reason for this among other things; for instance, nature of mathematical laboratory environment and facilities has significantly relation with students' learning outcome (Ebele & Abigel, 2018). They affirmed that whenever mathematics teacher use appropriate teaching aid, it result in high perceived usefulness in terms of enhancement of classroom instruction, learning effectiveness, and good academic performance. It assists individual differences and enriches students with adequate mathematics skills. Mathematical laboratory helps to build positive attitude towards mathematics and encourage group work. This brings joy to the students, gives evidence of progress to the student and ensures a greater transfer of learning through classroom procedure. The provision of equipped laboratory and learning materials enables students to frequently carry out laboratory exercise and enhance their understanding of mathematics concepts (Kajuru & Popoola, 2019).

There are researches conducted on teaching methods, instructional materials, infrastructural facilities, gender, etc, were enumerated by some authors (Kajuru & Popoola, 2019) as factors that affect students' performance in mathematics. Of all the variables listed, it seems that teaching method and instructional materials are mostly affect student performance in mathematics. The relevance of mathematics needs to embraces appropriate teaching strategies to the teaching of mathematics in

secondary schools is very significant. Kajuru and Popoola (2019) stated that effective teaching method and use of teaching aids allows students to enjoy services of ownership and direct involvement in judging the quality of students' performance in mathematics. Oloyede, Adebowale and Ojo (2018) also reported that teaching method of mathematics teacher is based on the students' performance in the subject. Ebele and Abigail (2018) indicated that learners' approach assist in reducing abstractness of the subject and facilitate understanding and consequently lead to improvement in attitudes and academic performance. Others strategies, that encourage students' participation, reducing abstractness of mathematics and promote good performance. These include: cooperative, problem-solving, scaffolding and discovery approach (Kajuru & Popoola, 2019).

The provision of guidance and counseling units in schools especially our secondary level is very important in improving students' academic performance and other related issues (Binta, 2023). Joy (2014) reported that most adolescent students were unrealistic in their choice of subjects and could not give them good foundation in science (mathematics). Joy (2014) indicated that the future choice of careers by students is shaped by the school subjects and as such a mandatory student guidance counseling service should be created in all Nigeria schools. From the foregoing, academic performance depends on many factors. In this study therefore, assessment of the impact of students' perception of mathematics on their choice of career subject in WAEC examination at secondary school level was sought in order to minimize the rate recorded at which students fail mathematics in secondary schools.

Statement of the Problem

Students express difficulties in understanding mathematics concepts taught to them by their teachers and performed poorly in internal and external examinations. Secondary mathematics education in Nigeria needs improvement to meet the aspirations of Nigeria as a nation and help to *promoting science and technology for sustainable national development*. It was observed that poor performance in mathematics in external examinations still exist (Akinsola, 2019 and Ajani & Popoola, 2019). The factors affecting poor performance varies from one school to another, from one set of students to the next and from one cultural setting to another. Since not all factors are relevant for a particular context. On this note, the researcher sought to investigate students' perception of factors affecting academic performance in mathematics at the Secondary School Level in Oshimili South Local Government Area of Delta State.

Purpose of Study

The main purpose of this study is to investigate and analyze students' perception of the contributory factors hindering academic performance in mathematics at secondary education as it affects education standard. Specifically, the study seeks to determine the following objectives;

1. Find out whether students' perceptions on mathematics anxiety have any effect on students' academic performance in mathematics?
2. Find out whether students' perceptions on teaching and communication skill of mathematics teacher have any effect on the students' academic performance in mathematics.
3. Find out whether students' perceptions on teacher's use of mathematical laboratory facilities/learning materials have any effect on students' academic performance in mathematics.
4. Determine whether students' perception on the mathematics teachers' teaching method have any effect on students' academic performance.
5. Determine whether students' perception on having counseling units in the school have any effect on students' academic performance in mathematics.

Research Questions

The following research questions guide the study:

1. Does students' perception on mathematics anxiety have any effect on students' academic performance in mathematics?
2. Do male and female students' perception on teaching and communication skill of mathematics teacher have any effect on the students' academic performance in mathematics?
3. Does students' perception on teacher's use of mathematical laboratory facilities/learning materials have any effect on students' academic performance in mathematics?
4. Does students' perception on the mathematics teachers' teaching method have any effect on students' academic performance?
5. Does students' perception on having counseling units in the school have any effect on students' academic performance in mathematics?

Research Hypotheses

The following hypotheses were tested at 0.05 level of significance.

H₀₁: There is no significant difference in the mean scores of male and female perceptions on the mathematics teachers' teaching method to have any effect on students' academic performance

H₀₂: There is no significant difference in the mean scores of male and female students' perceptions of teaching and communication skill of mathematics teacher to have effect on the students' academic performance in mathematics

Methodology

The study was descriptive survey. The population of the study comprises all the Senior Secondary School Three (SSS 3) Students in Oshimili South Local Governments Areas of Delta State. A sample size of 180 students which is made up of twenty students each were randomly from each of the nine schools randomly

selected. The study adopted Students Perception Questionnaire (SPQ) using Likert point scales of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) developed and validated by Joy (2014). The reported measure of internal consistency of the instrument is 0.73 using the method of test-retest (Joy, 2014). The instrument was administered to the study sample of one hundred and sixty (160) students from nine (9) senior secondary schools and retrieved back after one week. The data obtained from the SPQ were analyzed using mean and standard deviation, while the research hypotheses were tested using t-test statistics at 0.05 level of significance. The benchmark for decision is a mean of 2.5, that is, a mean score of 2.5 or above implies acceptance while a mean score below 2.5 indicate rejection.

Results

Research Question 1: Does students' perception on mathematics anxiety have any effect on their academic performance in mathematics?

Table 1: *Students' Perceived Responses on Mathematics anxiety Toward Mathematics*

S/N	Statement	Means	SD	Decision
1.	I enjoy studying Mathematics	3.84	0.76	Agree
2.	Mathematics as a subject has an Important role in my future care	4.15	1.99	Agree
3	Mathematics prepares me for life in a scientific technological society	3.32	1.15	Agree
4.	My Mathematics teacher praise and encourage me in the process of studying mathematics	3.70	0.56	Agree
5.	My Mathematics teacher is committed to the teaching of Mathematics	1.76	2.44	Disagree
6.	My Mathematics teacher is interested in the teaching profession	2.03	2.11	Disagree
7.	The mathematics teaching session is lively	3.05	1.11	Agree
8.	There is interaction in the Mathematics class	2.75	1.40	Agree
9.	The mathematics class lessons is Teacher centered	3.24	1.46	Agree
10.	Students participation is encouraged	4.25	0.66	Agree
Grand mean and Standard Deviation		3.21	1.36	

The results displayed in this Table 1, indicate students perception responses on mathematics anxiety towards mathematics lesson. The grand mean and standard deviation scores of respondents are 3.21 and 1.36 agreed that mathematics anxiety has an effect on mathematics performance expect in items 5 and 6, which has a mean value below benchmark 2.5.

Research Question 2: Does the teaching and communication skills of mathematics teacher have any effect on Students' academic performance in mathematics?

Table 2: *Students Perceived Responses on Teaching and Communication Skills of the Mathematics Teacher.*

S/N	Items	Mean	SD	Decision
1.	The mathematics teacher has a key role in teaching mathematics	3.56	0.49	Agree
2.	The mathematics teacher has complete mastery of the subject	3.23	1.26	Agree
3.	The mathematics teacher encourages students to express their view points	3.79	1.46	Agree
4.	The teaching method employed is suitable for teaching mathematics	3.54	0.76	Agree
5.	The teacher uses illustrations to describe mathematics concepts to students	4.02	1.19	Agree
Grand mean and Standard Deviation		3.63	1.03	

In Table 2, mean score 3.56 was recorded on responses on teaching and communication skills which revealed that the mathematics teacher has a key role in teaching mathematics while mean score 3.23 reported that mathematics teachers lacked mastery of the subject. Also mean score 3.79 perceived responses on no encouragement of students to express their view points and mean score 3.54 felt that the teaching method used in the teaching of mathematics was not suitable. Hence, the grand mean and standard deviation scores of respondents are 3.63 and 1.03 respectively agreed that the teaching and communication skills of mathematics teacher have effect on Students' academic performance in mathematics

Research Question 3: Does students' perception on teacher's use of mathematics laboratory facilities/learning materials have any effect on students' academic performance in mathematics?

Table 3: *Student Perceived Responses on Teachers used of Mathematical Laboratory Facilities and Learning Materials.*

S/N	Items	Mean	SD	Decision
1.	My school has enough mathematical laboratory facilities for teaching mathematics lesson.	3.56	0.97	Agree
2.	Visual and multimedia aids were provided	3.98	1.14	Agree
3.	There were provisions of instructional resource materials, such as internet facilities.	4.05	0.78	Agree
4.	Teachers of mathematics use the laboratory facilities in teaching	3.91	1.47	Agree
5.	The school has current mathematics laboratory	3.55	2.25	Agree
Grand mean and Standard Deviation		3.81	1.32	

The results displayed in Table 3 indicate on positive level of students' perceptions on majority of schools have no mathematical laboratory facilities and also instructional materials to carry out mathematics lessons which hinder performance in mathematics with grand mean and standard deviation scores of respondents are 3.63 and 1.03 respectively.

Research Question4: Does students' perception on teaching method have any effect on students' academic performance in mathematics?

Table 4: Student Perceived Responses on Teaching Method to have any effect on Students' Academic Performance in Mathematics

S/N	Items	Mean	SD	Decision
1.	The school strategy and activities are planned in advance by the mathematics teachers using demonstration method	3.15	1.56	Agree
2.	There are illustrations and activities to perform by game method	3.42	0.67	Agree
3.	Learning objectives are achieved by the students using co-operative method	3.73	1.14	Agree
4.	The teachers provide meaningful feedbacks on assignments by project method	3.19	0.46	Agree
5.	The mathematics concepts are from Known/at least difficult to more difficult using lecture method.	2.90	1.23	Agree
6.	Mathematics lessons are presented sequentially in a step-by-step approach by enquiry method	4.02	1.19	Agree
Grand mean and Standard Deviation		3.40	1.04	

Tables 4 indicates that mean scores 3.15 of the respondents revealed that mathematics teacher could not planned their works in advance and activities were not performed as it could be while about 3.42 shows that learning objectives are not achieved by the learners and that leads to no meaningful failbacks on homework giving to students. Mean value 3.73 represents that mathematics concepts are not treated from least difficult to more difficult and lessons were not presented sequentially. Therefore the grand mean and standard deviation scores of respondents are 3.40 and 1.04 respectively agreed that students' perception on teaching method have effect on students' academic performance in mathematics

Research Question 5: Does student's perception on provision of guidance and counseling unit in school have any effect on academic performance in mathematics.

Table 5: Student Perceived Responses on Availability of Guidance and Counseling Unit in the School

S/N	Items	Mean	SD	Decision
1.	There is a functional guidance and counseling unit in my school	4.25	0.66	Agree
2.	My counseling centre have enough office facilities/materials for counseling services	3.32	1.15	Agree
3.	There were provision of modern & challenging resource materials like internet, films& slides radio/tape recorder	3.36	0.72	Agree
4.	The counselor use the facilities in counseling	3.91	1.49	Agree
5.	I was guided in my choice of mathematics by guidance and Counseling officer	3.70	0.56	Agree
Grand mean and Standard Deviation		3.71	0.92	

Results presented in Table 5 revealed that the grand mean and standard deviation scores of respondents are 3.71 and 0.92 respectively which are above the benchmark. This shows that schools have no functional guidance and counseling unit and students were not well- guided on choice of subjects into senior secondary classes.

Hypothesis 1: There is no significant difference in the mean scores of male and female perceptions on the mathematics teachers' teaching method to have any effect on students' academic performance

Table 6: The t - test result of the mean scores of male and female perceptions on the Mathematics teachers' teaching method.

Gender	No. of Respondents (N)	Mean	SD	df	t-cal	t-cri	α	Decision
Male	90	3.15	1.56	173	5.58	1.96	0.05	Sig
Female	85	3.19	0.46					

The t - test result of the mean scores of male and female perceptions on the mathematics teachers' teaching method is given in Table 6. The calculated t-value (5.58) is greater than t-critical (1.96) at 0.05 level of significance. The null hypothesis of no significant difference in the mean scores of male and female perceptions on the mathematics teachers' teaching method have any effect on students' academic performance is therefore rejected. Therefore, there is significant difference in the mean scores of male and female perceptions of mathematics teachers' teaching method to have effect on academic performance in mathematics.

Hypothesis 2: There is no significant difference in the mean scores of male and female students' perceptions of teaching and communication skill of mathematics teacher to have effect on their academic performance in mathematics

Table 7: The t - test result of the mean scores of female and male students' perceptions of teaching and communication skill of mathematics teacher to have effect on their academic performance in mathematics

Gender	No. of Respondents (N)	Mean	SD	df	t-cal	t-cri	α	Decision
Female	90	3.56	0.49	170	0.37	1.96	0.05	Sig
Male	85	3.54	0.76					

In table 7, the t - test result of students' perceptions of teaching and communication skill of mathematics teacher to have effect on their academic performance in mathematics has been presented. The calculated t-value (0.37) is less than t-critical (1.96) at 0.05 level of significance. Therefore, the null hypothesis is not rejected; and concludes that there is no significant difference in mean scores of male and female students' perceptions of teaching and communication skill of mathematics teacher to have effect on their academic performance in mathematics

Discussion

The study on students' perception on factors affecting academic performance in mathematics in Oshimili South educational zone revealed substantial information as to some of factors affect performance in mathematics. It was observed that almost the mean scores are above the benchmark indicating that the respondents agreed that mathematics anxiety has effect on mathematics performance. This agrees with the finding of Asheraft and Kirk (2019), Ajani and Popoola (2019) that among the factors responsible to the deteriorating performance of students in mathematics is Mathematics anxiety. Mathematics anxiety commonly experienced by Students when learning a new mathematical task or when performing mathematical task and this leads to lack of interest in mathematics. Students with mathematical anxiety possess little or no confidence in their ability to solve mathematics problems (Ashcraft & S Kirk, 2019).

The findings on teaching and communication skills of mathematics teacher recorded that mean scores are above benchmark (mean of 2.5). This indicated that mathematics teacher has a key role in teaching mathematics as supported by the finding of Oloyede et.al (2018). The teaching methods that are learners centre provides instructiveness, friendliness and teamwork which in turn bring about better performance in mathematics. The items which focus on provision of mathematical laboratory facilities and learning materials are factors found to affect performance in mathematics. It was reported that means scores of students are above benchmark indicating that availability of mathematics laboratory facilities and learning materials are serious inadequate in most of schools. This agrees with study of (Shuaibu, 2023) that inadequate availability of laboratory infrastructure and other

related resources contribute significantly to poor students' academic performance. The teaching and learning of mathematics is essentially activity-based and thus requires appropriate facilities or resources for carrying out such activities. Since individuals need constructive knowledge that when given the appropriate stimulus! stimuli as supported by contemporary constructivist.

The findings revealed that all items which are stated on students' perception on teaching method were all rated agreed which implies no preparation of lesson and learning objectives are not achieved because no meaningful feedback. All these are attributed to teaching techniques, which seems to the teacher-centre referred to conventional teaching method. This method requires that the learner sit and listen to the teacher as he presents the content of the lesson. According to Kajuru and Popoola (2019) that students persistent poor performance in mathematics has been ascribed to inadequate teaching strategies adopted the teachers. This is due to persistent use of the conventional teaching strategy as one of the short coming affecting performance in mathematics. Results revealed that many schools have no functional counseling units and students do not received the effective guidance and counseling services which hinder better academic performance as confirmed by Binta (2023). Joy (2014) supported the view that school counselors should assist students to choose courses realistically and appropriately guided, strong foundation would be laid in mathematics.

Conclusion

Mathematics is at heart of many successful careers and therefore a gate to brighter future. Teaching and learning of mathematics is very vital because of its role in entrepreneurship, economic, mental and social development of the learner to ensure human and national development. It enables the learners to add value to you and contribute towards economic development of their society: This paper has therefore made some recommendations based on findings that will enable the individual and nation achieve their objectives stated in National Policy on Education on producing meaningful education for youth, which could make them self-reliant.

Recommendations

The following recommendations are made based on the findings emanating from this study:

1. Mathematics teachers should improve and develop appropriate classroom interactions to reduce mathematics anxiety, and pay attention to the students' previous experiences in mathematics.
2. Functional libraries with appropriate mathematics textbooks including e-libraries' should be provided by the state ministry of education so that mathematics students can frequently consult such textbooks and electronic libraries.

3. The necessary equipment and facilities required of a mathematical laboratory should be provided by the state government and individual should complement government efforts on that direction.
4. The state government should provide all the necessary resources required in a counseling centre to all the public senior secondary schools.
5. To this end, State government and Zonal Directorate Quality Assurance should introduce regular interactive sessions with school principals on ways and means of enhancing educational facilities in various schools under their zone.

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The Emergence of Virtual Classrooms in Nigerian Education: Benefits and Challenges in Teaching and Learning for Sustainable National Development

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Abstract

Technology is rapidly reshaping our world, and the world today is witnessing a remarkable digital transformation in various aspects of life, and education is no exception. Virtual classroom has emerged as a game-changer, transforming how we teach and learn by eliminating physical boundaries, they open up endless education opportunities. Virtual classrooms have become widespread in many countries, including Nigeria, revolutionizing traditional teaching and learning techniques. Also, the emergence of virtual classrooms has become increasingly vital in modern education, particularly in sustainable national development. This paper aims to explore the emergence of virtual classroom: the benefits and challenges in teaching and learning for sustainable national development. Through an extensive research, emphasis is drawn on the effectiveness of virtual classrooms in facilitating education access by highlighting the benefits and challenges of in the teaching and learning In consideration of the emergence of virtual classroom in education some recommendations were given, It is important for governments, educators, and policymakers to continue to invest in and support the integration of virtual classrooms into the education system to reap the benefits for future generations and drive sustainable national development amongst others.

Keywords: Virtual classroom, teaching and learning, sustainable national development, technology, benefits and challenges

Introduction

In the fast-paced digital age, education systems around the globe are constantly developing to meet the new demands of the modern era. One of the most significant advancements in recent times is the emergence of virtual classrooms, which have revolutionized the way teaching and learning take place. A virtual classroom is an online teaching and learning environment where teachers and students can present course materials, engage and interact with other members of the virtual class, and work in groups together (Wang,2019).The integration of technology in education has become not just magnificence but a necessity for sustainable national development.

Virtual classroom has become widespread in many countries, including Nigeria, revolutionizing traditional learning techniques. Virtual classrooms, as an innovative



approach to education, have gained momentum in recent years due to their potentials in enhancing teaching and learning experiences. The key distinction of a virtual classroom is that it takes place in a live, synchronous setting. Online coursework can involve the viewing of pre-recorded, asynchronous material, but virtual classroom settings involve live interaction between instructors and participants. Traditionally, teaching and learning occurred in physical classrooms, where teachers impart knowledge and students absorbed it through direct interactions. However, this traditional approach is no longer sufficient in meeting the demands of the rapidly changing world. The advancements in technology, especially the internet, have led to the emergence of virtual classrooms, transcending geographical boundaries and time zones. Classrooms leverage digital tools and communication platforms to facilitate learning experiences beyond the constraints of physical classrooms.

Literature Review

The dawn of advanced technology has revolutionized education in recent years, resulting in the growth of virtual classrooms as effective learning platforms. The global adoption of virtual classrooms has been witnessed across multiple countries, each utilizing them to address specific educational challenges. From personalized learning in the United States to reaching geographically isolated communities in Canada, Many researchers in their studies revealed that the impact in the utilization of virtual classrooms indifferent countries around the world in education continues to revolutionize education worldwide. Countries like Australia, Singapore, Saudi Arabia and the United Kingdom have also demonstrated successful integration of virtual classrooms to enhance academic engagement, intercultural exchange, inclusivity, and student-centered learning experiences. Singapore embraced virtual classrooms to optimize learning outcomes and enhance educational quality. The Ministry of Education (MOE) in Singapore introduced the Singapore Student Learning Space (SLS), a virtual classroom platform that offers interactive lessons, multimedia resources, and self-directed learning opportunities (Singapore MOE, 2020). This initiative effectively aligns with developments in educational technology.

According to Graham (2019), the United States has been at the forefront of adopting virtual classrooms nationwide. Graham (2019) revealed that blended learning models incorporating virtual classrooms are increasingly popular, providing flexibility and personalized learning experiences. Valuable platforms such as Google Classroom and Blackboard Collaborate (Lynch, 2018) have played a crucial role in the virtual classroom landscape. In Canada, virtual classrooms have gained momentum as a means to enhance educational access, particularly in remote areas (Bower, Kennedy, Dalgarno, Lee, & Kenney, 2018). A study by Bower et al. (2018) revealed that virtual classrooms have the potential to bridge the education gap by reaching students who lack access to traditional schooling due to

geographical or personal reasons. In another development, Virtual classrooms have gained recognition as an engaging and immersive educational tool in Australia (Anderson, Griffiths, & Markauskaite, 2016). Research conducted by Anderson et al. (2016) showcased how virtual classrooms were utilized with success in providing authentic learning experiences, promoting intercultural exchange, and fostering collaboration among students. According to Childress, McCoy, & Campbell, (2017) virtual classrooms have gained prominence in the United Kingdom to cater to diverse student needs. A study by Childress et al. (2017) identifies virtual classrooms as an effective tool to promote inclusivity, ensuring that students with disabilities or health issues can actively participate in learning activities.

Emergence of Virtual Classroom

Traditional education method of teaching and learning in Nigeria has faced several challenges and barriers, such as limited access to quality education, scarcity of qualified teachers, inadequate infrastructure, high cost educational resources, pandemics, cultural and language barrier and few others. These obstacles have restricted educational opportunities for many students across the country. However, virtual classrooms offer a promising solution by leveraging technology to bridge these gaps. The emergence of virtual classroom in education offers the potential to overcome traditional barriers and limitations, improve access to education, and provide a more flexible, robust and convenient learning experience for student This paper aims to explore the emergence of virtual classroom: the benefits and challenges in teaching and learning for sustainable national development.

Programmes Delivered Through Virtual Classroom

There are a many different types of programs that are delivered through virtual classrooms, the most common of which are:

1. **Massive Open Online Courses (MOOCs):** MOOCs, or Massive Open Online Courses, are virtual classes that are available for anyone to enroll and participate in. MOOC providers offer different types of courses. Some are accredited and some are not, some are offered through universities and some are not, some are free and some require tuition, and some are offered with live virtual classroom work and some are not. Examples of MOOCs include courses offered through Courera and edX.
2. **Online Degree Programs:** Online degree programs are offered by colleges and universities to deliver their degree programs in a virtual environment. Using online program management companies or their own internal resources, schools can recruit online students for their degree programs that are delivered into a webcam instead of a lecture hall. Many different schools offer online degree programs.

3. **Bootcamps:** Bootcamps are another example of courses that can take place using virtual classrooms. Bootcamps for web development, graphic design, and data analytics (among many others) are offered in virtual or in-person settings and provide students with concentrated education and training in an industry they are trying to break into or advance in. Examples of bootcamp providers include Thinkful, General Assembly, and Galvanize.

Benefits of Virtual Classroom in Teaching and Learning for Sustainable National Development

There are several benefits of virtual classrooms in teaching and learning for sustainable national development. Some of these benefits are discussed below: Virtual classrooms allow students from remote or marginalized areas to access quality education without the need for physical infrastructure. This enables equal educational opportunities, leading to more inclusive and sustainable national development (Scripta, Kuzminska & Kharchenko, 2020). According to Smith (2017), traditional education in Nigeria has faced various challenges, such as limited access to quality education, Virtual classrooms offer several benefits over traditional classroom settings, particularly in promoting education access and addition have the potential to bridge geographical barriers and provide students with access to quality education regardless of their geographical location. With a stable internet connection, students in rural or remote areas can now access renowned tutors, educational resources, and a range of courses from prestigious institutions within Nigeria or abroad. This access to quality education ensures that no student's potential goes untapped due to their location. Virtual classrooms eliminate the need for physical classroom setup, reducing infrastructure costs. It also saves travel expenses for both students and teachers. This cost-effectiveness enables governments to allocate resources to other crucial sectors, contributing to sustainable national development (Rasher & Mahamood, 2017).

Virtual classrooms offer flexibility in terms of timing and location, allowing students to personalize their learning experience. This flexibility enhances student engagement and performance, leading to better learning outcomes for sustainable national development (Lombardi, Tonizzo & Redaelli, 2018). Virtual classrooms offer a greater level of flexibility and convenience for both students and instructors. Students can access the course materials, lectures, and assignments at their own pace and preferred time, allowing them to learn at their convenience (Huynh, Umesh, & Kankanhalli, 2019). This flexibility enables students to better balance their academic obligations with other personal and professional commitments. Virtual classrooms also promote communication and collaboration among students and teachers through online platforms. This fosters multicultural understanding,



teamwork, and global networking, essential for sustainable national development (Olaru, Litmanovitz & Zlateva, (2021). Virtual classrooms provide the opportunity to incorporate various multimedia resources, such as videos, audio clips, and interactive presentations. These multimedia elements enhance the content delivery, making it more engaging and appealing to students (Adams, 2020). The integration of virtual classrooms enhances instructional methodologies. Virtual classrooms provide diverse multimedia resources, such as interactive videos, simulations, and virtual field trips, which engage students and promote active learning (Carlson, 2018). These resources facilitate personalized learning experiences, allowing students to grasp complex concepts at their own pace (Jones, 2020). Additionally, the integration of multimedia resources caters for different learning preferences and aids in knowledge retention which is important for sustainable national development.

Virtual classrooms allow for personalized learning experiences tailored to individual students' needs and learning styles (Adams, 2020). With the help of adaptive learning technologies, instructors can provide targeted feedback and resources to address each student's strengths and weaknesses. This personalized approach fosters self-paced learning and promotes academic success. Virtual classrooms significantly reduce the carbon footprint associated with traditional classroom setups. It eliminates the need for transportation, reduces paper usage, and minimizes energy consumption, contributing to environmental sustainability and a greener future (Pendarovski, Dimirovski, & Marcincin, 2019).

Virtual Classroom and its Impacts on Sustainable National Development:

The incorporation of virtual classrooms into the education system can have significant impacts on sustainable national development. By providing equal education opportunities for individuals from various socio-economic backgrounds, virtual classrooms promote social inclusivity and reduce disparities in education attainment (United Nations, 2020).

Virtual classrooms equip students with valuable digital skills, such as information literacy, communication, and problem-solving abilities, which are crucial for succeeding in a technology-driven world (United Nation Educational Scientific and Cultural Organization, 2019). Developing a digitally skilled workforce is essential for promoting economic growth and innovation, thereby contributing to sustainable national development.

Challenges of Virtual Classrooms in teaching and learning for sustainable National Development

Virtual classrooms offer opportunities for teaching and learning for sustainable national development, they also present challenges and these challenges need to be addressed in order to maximize the strong benefits of virtual classrooms for sustainable national development. These challenges include:



1. One of the challenges of virtual classrooms in teaching and learning for sustainable national development is the limited access to technology and internet connectivity. This can hinder the ability of students in remote or rural areas to participate fully in virtual classrooms (Kallioinen, 2019).
2. Lack of personal interaction and physical presence, which can affect the engagement and motivation of students. Without the physical presence of a teacher, it can be challenging for students to ask questions or receive immediate feedback on their work (Johnson & Wisniewski, 2019).
3. Virtual classrooms may lack the necessary resources and tools for effective teaching and learning. For example, hands-on experiments or group activities that require physical materials may be difficult to replicate in a virtual setting (Miller, 2020).
4. Virtual classrooms may face issues related to security and privacy. There is a need to ensure that students' personal information and online activities are protected in order to maintain a safe and secure learning environment (Bryant, Bryant, Miller, & Miller, 2021).

Conclusion

The emergence of virtual classroom has proven to be an effective tool in teaching and learning for sustainable national development. It has provided access to education for individuals who may not have had the opportunity otherwise, breaking down barriers such as geographical distance and financial limitations. The virtual classroom has also allowed for more flexibility in scheduling, accommodating the needs of working adults and allowing them to further their education. In addition, the virtual classroom has fostered a more inclusive learning environment, where students from diverse backgrounds and abilities can participate and engage in discussions. This has promoted a sense of global collaboration and understanding, preparing students for the interconnected world they will be entering upon graduation. Lastly, the virtual classroom has been instrumental in promoting sustainable national development by reducing the need for physical infrastructure and resources. This has resulted in cost savings and a reduced carbon footprint, contributing to the overall sustainability of the education sector. However, addressing challenges related to limited access to technology and internet connectivity, teacher-student interactions, and monitoring will be crucial for the successful integration of full potentials of virtual classrooms to drive sustainable national development.

Recommendations

In order to successfully integrate virtual classroom to drive sustainable national development, the followings are recommended.



1. It is important for governments, educators, and policymakers to continue to invest in and support the integration of virtual classrooms into the education system to reap the benefits for future generations.
2. Policymakers need to prioritize infrastructural development and provide support to ensure equitable access to technology for all students.
3. Institutions must invest in training and professional development programs to empower teachers with the necessary skills to engage and monitor students effectively in a virtual environment

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Impact of Digital Technology in Teaching of Science and Mathematics in Secondary Schools for Sustainable National Development

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Abstract

The purpose of this study was to examine the **impact of digital technology in science and mathematics teaching and learning for sustainable national development at senior secondary school in Oshimili North local government area of Delta State**. Two research questions and two hypotheses were raised for the study. The design adopted for the study was descriptive survey. The target population was all the senior secondary schools in Oshimili North **local government area of Delta State** with a sample size of 160 students which is made up of twenty students each were randomly drawn from each of the nine schools selected for the study. The instrument used for data collection was a questionnaire. Mean and standard deviation were used to analyze the research questions, while *t*-test statistics was used in testing the hypotheses. The findings from the study amongst others indicated that: The use of digital technology has drastically improved science and mathematics teaching and learning in educational sector. The study therefore recommended among others that: Digital technology should be used in teaching Mathematics and in the professional development of teachers' training and retraining programme; Government should provide the necessary funds to schools for the purchase of digital technology facilities like computer hardware for effective education delivery; The teacher should use digital resources like apps, social media etc to keep the class informed about activities and upcoming assignments.

Keywords: Digital Technology, science, Mathematics, Sustainable National Development

Introduction

Science and mathematics teaching and learning is greatly being influenced by new technologies which in turn influence school curriculum and practices. As science and mathematics teachers we witness these developing technologies and often wonder whether we are keeping pace with the emerging technologies in teaching and learning. The need for the science and mathematics teacher to ensure quality lesson delivery cannot be overemphasized. One of the fundamental components of the



United Nations sustainable development goals is quality education.. The experience of the recent COVID-19 pandemic brought to the fore the need for a paradigm shift in our old classroom practices. As we realized during the schools lockdown some schools could conveniently go on while some remained locked down without much activities. The schools that keyed into online lessons were schools that were equipped for that. With that experience digital transformation becomes a global imperative in today's world. The science and mathematics teachers need to understand these technologies as a means of enhancing his lessons and resources and at the same time engage in practices that will provide his students with tools and opportunities to place them in the global map.

The globalization of the world makes it imperative for the science and mathematics teachers and the students to acquire knowledge and skills that will impart on the society and the nation for sustainable development and global competitiveness. There is a strong consensus that digital technology can improve teaching and learning by motivating students with engaging, interactive and fun learning environment. According to Taylor, Fudje Mirriahi, and De Latt, (2021), digital technology offers new avenues of meaningful communication and collaboration between teachers and students. Digital technology in education has to do with introduction of new technology-assisted learning tools such as mobile devices, interactive white boards, smart boards, tablets, laptops, simulations, dynamic visualization and virtual laboratories. Traditional classroom instructions fall short of providing an immediate learning environment, faster evaluations, and more engagement. In contrast, digital learning tools and technology fill this void. With smart phones and other wireless technology devices becoming popular among the general public, it only makes sense that schools and educational institutions make efficient use of them by putting technology in the classroom. According to Haleem, Javaid, Qadri and Suman (2022), integrating technology into education provides students with an engaging learning experience, allowing them to remain more interested in the subject without being distracted. During the pandemic, digital classrooms became the order of the day in order to sustain the education system. Digital classrooms are defined by using electronic devices or platforms such as social media, multimedia and mobile phones to teach students.

With digital technology in education, today's educational landscape has altered for the better. Digital learning is a learning strategy that employs technology to fulfill the entire curriculum and allows students to learn quickly and rapidly. The digital classroom entirely focuses on teaching via the use of technology. Students use technological or internet-connected gadgets like laptops, tablets, chrome books etc. Instead of taking notes on what the teacher has taught, most of the curriculum is



delivered to students online through an engaging and interactive platform. Digital technology in the classroom refers to various software and gadgets meant to help students with particular accessibility needs. Digital technology means that devices can be more compact, faster, lighter and more versatile. Huge amounts of knowledge can be stored locally or remotely and moved around virtually immediately. Digital learning is any type of learning that uses technology. Digital learning is defined as any instructional practice that effectively uses technology to strengthen students learning experience and encompasses a wide spectrum of tools and practices. Examples of digital media include softwares, digital images, digital video, video games, web pages and websites, social media, digital data and data bases, MP3, electronic documents and electronic books.

Digital Technology is universal in society. There are new demands on educational systems in order to prepare students for further professions (Guo, 2015). The use of digital technology in the mathematics classroom has long been a topic for consideration by mathematics lecturers. Digital technology tools in mathematics include: portable, graphic calculator and computerized graphics, specialized software, programmable toys or floor robots, spreadsheets and databases. Access to technology via personal devices will increase, with the consequence that technology integration into mathematics education, within and outside the classroom, can be easily realized. Students will also have personal technology such as a tablet, a smart watch, a mobile phone or similar with which they are familiar to use mathematical focused applications. These tools are allowing pupils to collect data, and manipulate it using spreadsheets and databases for work in numeracy (Moseley, 2009). The use of digital tools in mathematics speeds up the graphing process, freeing people to analyze and reflect on the relationships between data (Hennessy, 2010). Mathematical specialists software such as Computer Algebra System (CAS), Dynamic Geometry System (DGS), Matrix Laboratory (Mat Lab), Statistical Package for the Social Sciences (SPSS) and so on. With the advent of such technology, the question arises as to what the impact on education and teaching practices should be in order to prepare the next generation of students for future careers (Clark-Wilson, 2015). Digital technology has the ability to assist teachers in improving the study and teaching of mathematics elsewhere. Students' mathematical performance has transformed due to their increased mathematical exposure (Cahyono & Ludwig, 2018). Teachers' greater use of digital materials will create a fresh experience for students learning mathematics, such as guaranteeing students are not bored (Wijaya, Zhou,, Houghton, Weinhandl, Lavicza & Yusop., 2022).

The purchase of new digital technology infrastructures slowed down in pace which made learning atmosphere to be non-conductive for effective learning. Digital technology has the ability to assist teachers in improving the study and teaching of

science and mathematics elsewhere. Students' mathematical performance has transformed due to their increased mathematical exposure (Cahyono & Ludwig, 2018). Teachers' greater use of digital materials will create a fresh experience for students learning mathematics, such as guaranteeing students are not bored (Wijaya et al., 2022).

Statement of the Problem

The national politics determines the quality of education policies, programmes and processes and eventually the products (results or outcomes). Government's underfunding and commoditization of education is likely to worsen the crisis in digital technology in education. Teachers encounter some challenges in the use of digital technology in science and mathematics teaching and learning. While some of the barriers are extrinsic that is external to the teacher some of the barriers are intrinsic arising from the teacher's attitude, beliefs and knowledge. The external barriers arise mainly from institutional challenges in the acquisition of digital technology equipment. If the school does not provide adequate computers and other digital resources, and lacks fast internet connection it becomes difficult to implement. Challenges internal to the teacher include challenges of inadequate training. Teachers need the skills and knowledge to be able to use technology in teaching, without which they lack the confidence in using it. These had negative effects on teachers and students. Therefore, concerned with this phenomenon, the study was conducted to examine the impact of *digital technology in science and mathematics teaching and learning for sustainable national development at senior secondary school in Oshimili South local government area of Delta State*

Purpose of the Study

The purpose of this study was to examine the impact of *digital technology in science and mathematics teaching and learning for sustainable national development at senior secondary school in Oshimili North local government area of Delta State*. Specifically the study sought to:

1. Find out the use of digital technologies by science and mathematics teachers *for sustainable national development*.
2. Find out the Challenges encountered in the use of digital technology in science and Mathematics teaching and Learning for sustainable national development.

Research Questions

The following research questions guided the study;

1. What digital technologies are used by science and mathematics teacher *for sustainable national development?*

2. What are the challenges of digital technology in science and mathematics teaching and learning *for sustainable national development?*

Hypothesis

The following null and alternative hypotheses were formulated and tested at 0.05 level of significance.

HO1: There is no significant difference between the mean responses scores of male and female teachers on the use of digital technologies by science and mathematics teachers and the challenges encountered by teachers as a result *the use of digital technology in science and mathematics teaching and Learning for sustainable national development.*

HO2: There is significant difference between the mean responses scores of male and female teachers on the use of digital technologies by science and mathematics teachers and the challenges encountered by teachers as a result *the use of digital technology in science and mathematics teaching and learning for sustainable national development.*

Methodology

The study adopted a descriptive survey design, since the opinion of the respondents was collected from the field. The target population was all the all the senior secondary schools in Oshimili North educational zone of Delta State. The sampling technique used for the study comprises of a sample size 160 respondents which is made up of twenty students each were randomly selected from each of the eight schools for the study. The instrument used for data collection was a questionnaire. The respondents were requested to express their opinions on a 4-point modified Likert response scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with their weight ranging from 4-1 for positively skewed items and vice-versa for negatively skewed items. The instrument was validated by two experts who certified them fit for the study with a reliability coefficient of 0.74. Data collected were analyzed using mean and standard deviations and t-test statistics to test the hypothesis. The results of the study were obtained from the research questions answered through data collected analyzed. Any item with a mean score of 2.50 and above was adjudged to agree, while item with a mean score below 2.50 is adjudged to disagree.

Results

Research Question 1: What digital technologies are used by science and Mathematics teachers for **sustainable national development?**

Table 1: Mean and Standard Deviation Results on the Use of Digital Technologies by Science and Mathematics Teachers for Sustainable National Development.

S/N	ITEM	Mean	SD	Decision
1.	Smart Mobil devices ensure quality lesson delivery	3.60	0.55	Agree
2.	The use of laptops help students in classroom instruction	3.45	0.63	Agree
3.	The use of interactive white boards improve students' learning abilities	3.36	0.72	Agree
4.	Smart board devices provide students with an engaging learning experiences	3.00	0.97	Agree
5.	Dynamic visualization and virtual laboratories are used to improve students' learning abilities	3.20	1.03	Agree
6.	Digital technology tool such as stimulation is used for faster evaluation and engagement	3.15	1.07	Agree
Grand Mean and Standard Deviation		3.22	0.85	Agree

The results obtained from Table 1 shows that all items were agreed with a grand mean and standard deviation scores of 3.22 and 0.85 respectively. This implies that the use of digital technologies by science and mathematics teachers **for sustainable national development help** to access computer hardware for effective education delivery and Smart board devices provide students with an engaging learning experiences among others in Osimili North Local Government Area of Delta States of Nigeria

Research Question 2: What are the challenges of digital technology in science and mathematics teaching and learning **for sustainable national development?**

Table 2: Mean and standard Deviation Results on the Challenges Encountered by Teachers in the Use of Digital Technology in Science and Mathematics Teaching and Learning for Sustainable National Development.

S/N	Item	Mean	SD	Decision
1.	Lacks fast internet connection	3.63	0.57	Agree
2.	Inadequate computers and other digital resources,	3.56	0.78	Agree
3.	Inadequate training of Teachers in the use of technology	3.36	0.80	Agree
4.	Inadequate staff training through workshops and conferences	3.19	0.91	Agree
5.	Inadequate grant to schools for effective digital technology equipment	3.32	0.94	Agree
6.	Lack of experience in the use digital technologies	3.32	1.06	Agree
7.	Digital technology may be distracting to students	2.80	1.07	Agree
Grand Mean and Standard Deviation		3.31	0.88	

The results obtained from Table 2 shows that the grand mean and standard deviation for the respondents were 3.31 and 0.88 respectively. The table also shows that all items were agreed with mean scores ranging from 2.80 to 3.58. This implies that the items posed challenges to teachers as a result of lack of digital technology tools in science and mathematics teaching and learning *for sustainable national development*.

HO1: There is no significant difference between the mean responses scores of male and female teachers on the use of digital technologies by science and mathematics teachers and the challenges encountered by teachers as a result *the use of digital technology in science and mathematics teaching and Learning for sustainable national development*

Table 3: Independent Sample t-Test Analysis on the Mean Responses of Male and Female Teachers on the *Impact of Digital Technology in Science and Mathematics Teaching and Learning for Sustainable National Development*.

Gender	(N)	Mean	STD	Df	tcal	tcri	A	Significance
Female	80	3.22	0.85	15	0.864	1.98	0.05	Accept H1
Male	80	3.31	0.88					

Table 3 reveals the mean responses of the male and female teachers on the *impact of digital technology in science and mathematics teaching and learning for sustainable national development*. The result shows that t_{cal} score of 0.864 which is less than t_{cri} score of 1.98 means the null hypothesis (H_0) should be rejected. Hence, the alternative hypothesis should be accepted.

Therefore, it is clear from the result that there is significant difference between the mean responses scores of male and female teachers on the use of digital technologies by science and mathematics teachers and the challenges encountered by teachers as a result *the use of digital technology in science and mathematics teaching and learning for sustainable national development*.

Discussion

The findings of the study as presented in Table 1 indicates that the use of digital technology has drastically improved science and mathematics teaching and learning in education sector which were strongly agreed by the teachers as a result of accessibility to the computer hardware for effective education delivery and smart board devices provide students with an engaging learning experiences among others. This is in agreement with (Wijayaet al 2022) that Teachers' greater use of digital materials will create a fresh experience for students learning mathematics, such as guaranteeing students are not bored. They reported that digital technology



offers new avenues of meaningful communication and collaboration between teachers and students and lack of funds for the purchase of new technology-assisted learning tools such as mobile devices, interactive white boards, smart boards, tablets, laptops, simulations, dynamic visualization and virtual laboratories hardware stands out as the number one problem confronting the teaching and learning of core subjects

The result of the analysis in Table 2 shows the challenges of digital technology in science and mathematics teaching and learning *for sustainable national development*. This finding is in agreement with Haleem et al (2022) that integrating technology into education provides students with an engaging learning experience, allowing them to remain more interested in the subject without being distracted.. They express that many teachers lack of knowledge about ways to integrate digital technology to enhance the curriculum and to integrate and use different digital tools in a single class session. These conditions bring about divided attention and poor concentration on the teaching job thereby reducing their output. Some become unnecessarily harsh to students and would not take time to give proper explanation on any concept taught using digital technology, as students' lose interest in class activities thereby affecting the impartation of such knowledge.

The result of the analysis in Table 3 reveals the mean responses of the male and female teachers on the *impact of digital technology in science and mathematics teaching and learning for sustainable national development* In addition, higher number of respondent agreed that the alternative hypothesis should be accepted. Therefore, it is clear from the result that there is significant difference between the mean responses scores of male and female teachers on use of digital technologies by science and mathematics teachers and the challenges encountered by teachers as a result of *the use of digital technology in science and mathematics teaching and learning for sustainable national development*.

Conclusion

Sustainable development goals emphasize quality education as one of the global goals. Digital technology is a gateway to the world for today's student and when applied in science teaching and learning will equip students with skills and knowledge relevant in today's world. Digital technology is needed to promote learning and position our students to be globally competitive. The digital transformation needed in today's world became more evident during the COVID-19 pandemic which accelerated the need to rapidly adopt digital solution.

Recommendations

Based on the above, the following recommendations were made:

1. Digital technology should be used in teacher education and in the professional development of teachers' training and retraining programme.



2. Government should provide the necessary funds to schools for the purchase of digital technology facilities like computer hardware for effective education delivery.
3. The teacher should use digital resources like apps, social media etc to keep the class informed about activities and upcoming assignments
4. There is need for adequate provision of equipment and infrastructures by the government for teachers to perform their duties diligently.

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Influence of Single Parenting on the Academic Achievement of Students in Oshimili North Local Government Area of Delta State

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Abstract

The study examined influence of single parenting on the academic achievement of students in Oshimili North Local Government Area of Delta State. The population of the study comprised all secondary school students in Oshimili North L.G.A. of Delta State. The sample consisted of 150 respondents (50 from each school), selected from three (3) public secondary schools in the area of study. The instrument used for data collection was a 19-item questionnaire. Two experts validated the instrument and it was trial tested and a consistency of 0.70 was established as the reliability. The data collected were analyzed quantitatively using descriptive and inferential statistics to explore associations among variables and the results of the study revealed that single parents has influence on the academic performance of students. The finding also revealed that single parents' level of education has influence on the academic performance of students. Further finding also revealed that there is a significance difference in educational achievement between students from single and intact families. It is therefore recommended that law court, and social agents such as home, should discourage divorce and separation at all cost. Furthermore, Schools can devise special teaching strategies to meet the needs of the students who are raised up by single parents

Keywords: *Single parenting, student, secondary education, family structure, academic achievement*

Introduction

Education is the process by which an individual develops knowledge, skill, habit and attitude that are expected to enable one to become a good citizen. Transmission of knowledge, skills, character and traits and manifest in various forms. According to Plato, education is the transfer of knowledge from one generation to another and it is when one can be said to have acquired discipline (Plato, 428/427 348/347BC). The academic achievement of students at various levels of education and particularly at the basic level can be predicted on many factors such as institutional factor, social economic factors, motivation factor and family which is considered as the primary agent in terms of socialization (Olayinka, 2009). The family plays a major role during socialization, because a child is completely dependent on others especially



family members in order to survive. Parents in particular are responsible for teaching their children how to function, care for themselves and how to fit in the outside world from infancy and through the years of basic education.

With the increase in single parenting in the society, there are views that the children from such homes may not do well academically. Anyakoha (2016), Azuka-Obieke (2013) and Ojo, (2019), though in different studies agreed that single parenting has a negative effect on the academic performance of the students. Also, Ushie, Emeka, Ononga and Owolabi (2012), findings with excellent and brilliant performance revealed that 2.6% and 7.9% came from single parent and dual parents respectively. This implies low academic achievement of children of single parents, with few exceptions. However, Hiko, Cakici and Baysen (2023), in their studies concluded that single parenting does have a significant negative effect on the students' academic performance.

This study therefore focuses on examination of the influence of single parenting on the academic achievement of senior secondary students in Oshimili North Local Government Area of Delta state. In most cases, life with only a single parent is often seen as a risk (Olayinka, 2009) but in recent years single parent has continued to become a common thing, thus making it a focus of the study in relation to its influence on academic achievement of learners. Studies on the role of the family on academic achievement by learners have been carried out using two types of family model namely: family deficit model and risk factor, protective factor model (Black family initiative organization, 2015). According to family deficit model, single parent families have a negative impact on children; simply because they do not have a nuclear family structure. This implies low academic achievement of children of single parents, with few exceptions. The model begins with an assumption that single parenting is bad for children thus overlooking other factors which can influence academic achievement.

On the other hand, the risk and protective by Schumacher, Smith, and Hayman (2011) have a contrary idea as it views that all families have advantage and disadvantage. Nevertheless, observations have shown that students from single parent families are at a greater risk of not performing well academically compared to other types of families, despite the fact that they may have equal intellectual abilities (Lankard, 1995). They are likely to have higher chances of dropping out of school due to financial constraints. Hence, finance is one of the hindrances to children of single parents' academic achievements. Asah (2021) in his studies asserted that finance among others can influence academic performance of children of single parents. This may be attributed to the fact that the single parent may not be in a position to provide all the basic needs for the family and the child may be forced to drop out of school to assist the parent financially.



The single parents again may not be in a position to monitor the academic progress due to their busy schedule as they spend most of their time trying to earn a living. Thus, unable to give the children adequate and quality time, guidance, discipline and assist their children with academic matters. The consequence of parental divorce vary and depend on a variety of factors; the absence of one parent has serious consequences on the adolescent as a single parent mother-led home experience lower house hold income which eventually influence the educational opportunities and success in school.

Increase in number of single parent families may mean that a large number of children are likely to experience problems associated with single parenting due to limited parental contact, economic deprivation, decrease in parental control and effective control. Billings (2012), in his studies, stated that children from such homes become delinquent because they are most often deprived of security, protection and love that should come from both parents and these impact negatively on academic success of the child. In Ghana and South Africa, a study conducted by UNICEF, established that students' performance in school was greatly determined by the family background in terms of single parent family, parent's level of education and income which are determinants of children's attainments. This is in congruence with Okello and Kikemeko (2021); Igandu, Odek and Marima (2020) also, Arthur and Pauline (2017) whose work revealed that parent's level of education, income among others significantly influence academic performance of students.

In a study conducted in 1997 by the Government, UNICEF and the family support institute in 13 districts in Ghana found 45 percent of the families had both parents' presents and 55 percent were headed by single parents indicating the rate of single parenthood is alarming. In Kenya, single parent families are also increasing at a very rapid rate. This is due to modernization and urbanization which in turn contributed to breakdown of traditional structure. In Nigeria, gender role are culturally determined, material role concerns childcare and home making, while the parental role takes up the economic responsibilities and discipline of children. It is therefore the responsibility of the parent to train and bring up the child in the norms and value of the society. The parents are responsible for the educational and career development of their children. However, divorce and separation of various kinds may leave parental roles in the hands of a single parent. Developed countries in particular are experiencing increase in single parent families as divorce which is one of the most controlled factors of single parenting has become more common.

The phenomenon of single parenting, therefore, is not only a social problem but a global one which demands recognition and serious attention. As a result of this, the research is interested in examining influence of single parenting on the academic performance of student in Oshimili North Local Government Area of Delta State. The researcher intends to investigate the variables in single parenting with a view of assessing their relative influences on the academic performance of secondary school students in Oshimili North Local Government Area of Delta State.

Statement of the Problem

Literature seemed to suggest that by and large single parent families are poorer compared to families with two parents in terms of time, attention and financial help from single assistance they give to their children and therefore children coming from single parent families in Oshimili North poverty level is alarming and more likely to face socio-economic challenges as well as social- emotional support. Given that literature has on the whole indicated that there is a relationship between single parenting, poverty and academic achievement of children. Many cases of indiscipline, depression, drug use and abuse, suicide, poor academic performance in schools and ability to relate well with peers among secondary school students may be attributed to their parents' marital status. It is important to investigate the extent to which single parenting has influenced academic achievement of children in Oshimili North Local Government Area of Delta State. The variable of investigation included the effect of single parents' involvement in their children's education, level of single parents' education, finances and family on children's academic achievement.

Purpose of the Study

The main purpose of this study is to examine the influence of single parenting on the academic achievement of students in Oshimili North Local Government Area of Delta State. The specific objectives of the study are:

1. To find out how single parenting affect parent's involvement on students' academic achievement.
2. To ascertain the influence of single parents' level of education on the academic achievement of student from single parents home.
3. To determine the influence of single parents' financial situation on students' academic achievement.

Research Questions

1. How does single parenting affect parents' involvement on students' academic achievement in secondary schools in Oshimili North Local Government Area of Delta State?
2. How does the single parents' level of education influence students' academic achievement in secondary school?
3. How does single parents' financial status affect students' academic achievement in secondary school?

Research Hypothesis

In the pursuit of the research problem and to realize the objective of this study, the hypotheses was raised and tested at 0.05 level of significance.

1. Ho1: There is no significant difference on the influence of parental background on educational achievements between students of single parenting and double parenting.



Methodology

This study adopted a descriptive survey method that is aimed at collecting data for the purpose of interest and knowing the influence of single parenthood on the academic performance of secondary school students. The population of the study consists of SS1 and SS11 students in Oshimili North Local Government Area of Delta State. The target sample of the study consists of students in SS1 and SS11 drawn from three secondary schools in Oshimili North Local Government Area of Delta State. The sample size for the study comprised 150 students drawn from three (3) secondary schools in Oshimili North Local Government Area of Delta State. In each of the sample schools, 50 students (25 SS1 and 25 SS11) were randomly selected from three (3) secondary schools. It took the researcher three (3) days to accomplish the task as each day was dedicated to one school. Hence, 150 copies of the administered instrument representing 100% were returned duly completed. The instrument for data collection in the study was a self-developed questionnaire, containing 19- item statements titled: Single-Parenting Influence on the Academic Achievement of Students Questionnaire. The instrument was divided into two (2) sections; Section “A” had provision for respondents' bio-data while section “B” had statements designed to elicit responses from the respondents on questions related to the issues raised from the research questions and section B contained 19-items statements. The instrument was a four-point rating scale type with options tagged; strongly Agree (SA = 4 points), Agree (A = 3 points), Disagree (D = 2 point), Strongly Disagree (SA = 1 point).. The instrument was constructed by the researcher and given out to the supervisor and two other experts in the field for appropriate validation. Face and content validities of the questionnaire were done; item not valid were dropped. The questionnaire was trial tested to groups of students from other local government. The exercise was done at two occasions with an interval of two weeks for test-re-test method of reliability. The scores obtained at the two occasions from those groups were correlated using Pearson's Moment Correlation Coefficient and value of 0.70 was obtained. In view of the large population of the respondents for the study, the researcher made use of one research assistant. The research assistant was recruited from among secondary school teachers in the study area. The researcher briefed the research assistant on the objective of the study. This enabled him explain certain item on the questionnaire to the respondents so that the questionnaire would be properly filled. The questionnaire was administered by the researcher and the researcher assistant face to face to the respondents and collected on the spot. This method ensured correct completion and high percentage return of completed questionnaires..The data collected were analyzed using mean and standard deviation. The hypothesis was tested using chi square statistics

Results

Research Question One

How does single parenting affect parent's involvement on student's academic achievement in secondary School?

Table 1: Parents' Involvement on Student's Academic Achievement in Secondary School (N = 150)

S/N	Statement	Mean	Std	Decision
1.	I interact well with my parent	1.59	0.73	Disagree
2.	My parent help me to plan my time at home	2.07	1.13	Disagree
3.	My parent always check my performance at school on daily basis	1.87	0.89	Disagree
4.	My academic performance is not very encouraging because my parent does not help me	3.20	0.95	Agree
5.	Single parenthood leads to less academic supervision to the child which leads to better performance in school.	1.75	0.83	Disagree
6.	My parent have time to supervise my studies at home	1.70	0.69	Disagree
Grand Mean and Standard Deviation		2.03	0.87	Disagree

Table 1 shows the mean rating of respondents on the opinion of students regarding single parenting and its influence on the academic performance of students. Table 1 revealed that items 1, 2, 3, 5, 6 were disagreed to by the respondents except item 4 with a mean score of 3.20 which is significantly higher than the criterion mean of 2.50. The mean score for all the item range between 1.59 and 2.03 with a grand mean of 2.03 and grand standard deviation of 0.87. The result from the study revealed that single parent, seldom interact well with their children, plan their children's time at home, check their performance at school on daily basis, also hardly supervise their wards' work at home. However, the item 4 revealed that lack of help from the single parent does not lead to poor performance.

Research Question Two

How does the single parents' level of Education influence students' academic performance in secondary school?

Table 2: Influence of Single Parents' Level of Education on Students' Academic Achievement in Secondary Schools (N = 150)

S/N	Items	Mean	Std	Decision
7.	My parent has enough education to properly guide my study at home.	2.27	0.93	Disagree
8.	My parent provides all my needs for study.	1.71	0.81	Disagree
9.	I always study at home	3.13	0.92	Agree
10.	I have friendly environment for my studies at home	1.90	1.01	Disagree
11.	My parent visit my school regularly to find how I am doing	1.70	0.83	Disagree
12.	My parent ensure I do my homework regularly	3.17	0.97	Agree
13.	My parent check my notes regularly	1.73	0.93	Disagree
Grand Mean and Standard Deviation		2.23	0.91	Disagree

Table 2 shows that items 7, 8, 10, 11&13 were disagreed by the respondents. This is because the mean scores for the items ranged between 1.17 and 2.27 and were less than the criterion mean of 2.50. The grand mean for the table was 2.23, which further confirms disagreement .while items 9 and 12 were agreed. The result revealed that single parent does not have enough education to properly guide their children's study at home, does not provide all they need for study, no friendly environment for study for the children, does not visit their children's school regularly to find how they are doing and also does not check the children's note regularly. It also revealed that the children from single parent homes always study at home and the parent ensure that they do their homework regularly.

Research Question Three

How does single parent's financial situation affect students' level of educational performance?

Table 3: *Influence of Single Parents' Financial Situation on Students' Academic Performance in Secondary Schools*

S/N	Statement	Mean	Std	Decision
14.	Students whose parents earn higher income , achieve better academically than those whose parents earn lower	1.73	0.75	Disagree
15.	Single parents on high income can afford to provide the basic necessities required for their children’s education than those on low - income.	3.33	1.64	Agree
16.	Students whose parents are on high – income status can have higher career aspiration than student whose parent are on low – status	3.07	0.84	Agree
17.	Single parents who are on high and middle income status can train their children beyond primary school level	3.25	0.85	Agree
18.	Parents who are not highly paid find it difficult to provide learning materials needed to make achievement easy	3.03	1.15	Agree
19.	Poor single parent can only enroll their children into public schools where their achievement depend on their potentials	2.67	0.93	Agree
Grand Mean and Standard Deviation		2.85	1.03	Agree

Table 3 showed that Items 15, 16, 17, 18 and 19 with mean 3.33, 3.07, 3.25, 3.03 and 2.67 were agreed to by the respondents, which is higher than the criterion mean of 2.50. While item 14 with mean 1.73 expressed disagreement. The grand mean of 2.85 further confirms agreement. The result revealed that single parent on high income can afford to provide the basic necessities required for their children's education, can have higher career aspirations, can train their children beyond primary school, will not find it difficult to provide learning materials needed to make achievement easy than those on low- income. It further revealed that students whose parents earn higher income may not achieve better academically than those whose parents earn lower.

Test of Hypothesis

HO₁: There is no significant difference on the influence of parental background on educational achievements between students from single parenting and those from dual parenting.

Table 4: Educational achievements of students from single parenthood and dual parenthood

Marks	Grade	Remark	Frequency	Single Parent	Dual Parents	X ²	Df	Alpha Level
44 & below	F9	Failed	50	40	10	30.82	8	0.05
45-49	E8	Pass	30	13	17			
50-54	D7	Pass	17	9	8			
55-59	C6	Credit	12	6	6			
60-64	C5	Credit	20	8	12			
65-69	C4	Credit	10	2	8			
70-74	B3	Good	5	2	3			
75-79	B2	Very Good	4	0	4			
80+	A1	Excellent	2	0	2			
Total			150	80	70			

Table 4 shows Chi-square goodness of fit test of no significant influence of parental background on students' educational achievement. A Chi-square value 30.82 was obtained; testing at 0.05 level of significance at degree of freedom of 8 with X² tabulated value of 15.51. Since the obtained X² value of 30.82 is greater than the X² tabulated value of 15.51, the tested null hypothesis which states that “there is no significant difference on the influence of parental background on students' educational achievement” is rejected. Hence, there is statistically significance difference in educational achievement between students from single and dual families.

Discussion of Results

Finding in the study revealed that single parent, seldom interact well with their children, plan their children's time at home, check their performance at school on daily basis, also hardly supervise their wards' work at home This agrees with the findings of Ojo (2012) and Ushie *et al.* (2012) that single parents have a negative influence on the academic achievements of their children. The finding in the study also revealed that single parent does not have enough education to properly guide their children's study at home, does not provide all they need for study, no friendly environment for study for the children, does not visit their children's school regularly to find how they are doing and also does not check the children's note regularly.

These findings align with the findings of Authur and Pauline (2017)who reiterated that parent's level of education had a direct correlation with student's academic performance. Findings in the study further revealed that single parent on high income

can afford to provide the basic necessities required for their children's education, can have higher career aspirations, can train their children beyond primary school, will not find it difficult to provide learning materials needed to make achievement easy than those on low- income. This is in congruence with the work of Asah, J. (2021). whose finding revealed that financial constraints among others can influence academic performance of students. Test of hypothesis indicated that there was statistically significance difference in educational achievement between students from single and intact (two) parent families because the X^2 calculated value of 30.82 was greater than the X^2 table value of 15.51. The discussion of the respondents pointed out that majority of the dual parent children achieve well academically.

Summary of Findings

1. Single parenting influence students' academic performance negatively
2. Single parent's level of education influence students' academic performance negatively
3. Single parent's financial situation affects students' academic performance negatively
4. There is a significant difference in the academic performance between students from single and dual parents

Conclusion

This study has confirmed that academic performance and single parenting are negatively related, hence the more cases of single parenting the poorer the academic performance. With more women as a single parent, couple with menial jobs that some women do and their meager income size, the single parent household are not able to meet the most basic necessities of life (e.g food, shelter, clothing) let alone expenditure on investment like education which turn to postpone current consumption in the wake of single parenting. Divorce is the major cause of single parenting in Nigeria. This clearly indicates that marriage as an institution is contributing little in promoting children's welfare as future leaders. Because of the financial stain experienced by many single mothers, they tend to be more anxious, depressed and overwhelmed with parenting issues. Problems facing single parenting can be viewed in terms of psychological trauma, financial problems, child labor and poor social factors which consequently lead to poor academic performance of students.

Recommendations

The following recommendations have been made based on the following of the study:

1. The academic performance and single parenting are negatively correlated. Therefore schools can device special teaching strategies such as group studies, practical activities to meet the needs of this student. It would be

- proper for every school to assign teachers, mentors to the students who suffer from trauma as a result of single parenting; preferably those of the opposite sex to complement the vacuum lost at home.
2. There can also be guidance and counseling department in every school where the psychological, emotional and academic challenges of the students could be tackled. This practice would enable the teachers to familiarize themselves with the parents of their students for possible suggestion on how to deal with the challenges.
 3. Government and other stakeholders should economically empower single parents through provision of business advisory services and financial support to engage and expand their businesses. Parents who would want to go into farming should be encouraged and supplied with tools and skills that will make desirous move from the subsistence farming to commercial farming by both the government and other non- governmental agencies who seek to promote relief and service to the needy.
 4. All parents should be encouraged through the Parent-Teacher Association (PTA) to create time for their children for their homework activities. This is to ensure that the learners do their school assignments under the supervision of their parents, whether they are single or dual (intact) parent families.
 5. The Judiciary and social agents such as homes and churches should discourage divorce and separation at all cost.

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Teacher's Knowledge on The Challenges And Influence of School Health Environment On Academic Performance of Learners In Adult Literacy Programmes: Implication For Sustainable Development

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Abstract

The study evaluates teacher's knowledge on the challenges and influence of school health environment on academic performance of learners in adult literacy programmes in Oshimili South Local Government Area of Delta State. Three research questions guided the study. The study adopted descriptive survey design. The population consisted of eighteen (18) adult educators in adult literacy centres in Oshimili South Local Government Area; hence the sample size is 18 adult educators. Purposive sampling techniques was adopted to enable the researchers to use the limited size of the population. A research instrument was used to collect the data which was self-designed questionnaire by the researchers titled; Teacher's Knowledge on challenges and influence of School Health Environment on Academic Performance of Learners Questionnaire (TKCISHEAPLQ). Data collected were analyzed using mean statistic and standard deviation. The findings revealed that teachers in basic literacy centers in Oshimili south Local Government Area of Delta state are knowledgeable on the influence of emotional and social health environment on academic performance of learners, and as well agreed that the centers are facing series of physical challenges that can hinders learners academic performance such as un-conducive environment, poor settings and accommodations amongst others. Therefore the study recommended among others that, Governments should give significant consideration to adult literacy centers by allocating sufficient fund and formulating policies that support the creation of emotionally safe and conducive environments in adult education settings, recognizing the interconnectedness of emotional, social, and physical well-being to learning and sustainable development.

Keywords: Health, basic literacy, Adult. Adult education, environment, adult centers

Introduction

For a long time, adult education programmes have been dominated by the use of inappropriate learning environments as well as methods (Lawson, 2018). This trend compelled adult education scholars like McMahon (2018) to contend that the inappropriate application of adult education has rendered the field ineffective. One



of the issues raised was the use of teaching as opposed to facilitation. It has been contested that the use of teaching in adult education is domineering and presupposes that the person to be taught is an empty vessel. An adult has an array of experience and it is on this experience that learning of new ideas can be built. Facilitation is advanced as being ideal in the practice of adult education. The assumption being that adult learners are self-directed learners, they are focused and they can only learn what they feel is important to their needs. Therefore, the role of planners and facilitators of adult learning programmes is to create optimal learning environments where learners are allowed to assume responsibility for their learning. Most importantly, the role of the educator is to facilitate learning by engaging the learners in dialogue.

Schools are the only institutions that can nearly reach all learners and are in a unique position to improve the education and health status of learners with a suitable healthy environment. School health environment refers to the overall conditions and factors within a school setting that can influence the physical, mental, and social well-being of adult learners and staff. It encompasses various elements that contribute to the health and safety of everyone within the school community. Akani and Nkanginieme (2017) define school health environment as “one that protects learners and staff against immediate injury or disease and promotes prevention activities and attitudes against known risk factors that might lead to future disease or disability.” According to World Health Organization (2018) school health program ensures that learners are in optimal health at all times to attain their physical and intellectual potentials as well as receive moral benefits from their health providers and facilitators in Adult Literacy Programme.

An adult literacy program is an educational initiative designed to help adults (typically 18 years and above) improve their literacy skills. These programs are essential for individuals who may not have had the opportunity to acquire adequate reading, writing, and numeracy skills during their formal education or who need to enhance these skills for personal or professional development. It is essential for the learners to put into operation, the learning methods in an appropriate manner to facilitate learning. It is usually recommended that adult literacy centres should acquire an understanding of the importance of suitable school health environment which helps to improve the interest of adult learners and to learn with ease. Therefore, the meaning and significance of adult literacy programs are acknowledged when the adult learners are able to understand the teachers teaching and learning methods in a suitable healthy environment.

The study highlights key areas of knowledge that teachers should possess regarding school health and safety in adult literacy programs, as suggested by United Nations Educational, Scientific and Cultural Organization (UNESCO) (2016). Firstly, teachers should be aware of the physical conditions of the learning space, ensuring it



is well-ventilated, well-lit, and free from potential hazards. They are expected to report maintenance issues to the appropriate authorities. Secondly, teachers should educate adult learners on good hygiene practices, maintain clean facilities, and promote sanitation. Thirdly, teachers can contribute to health promotion by discussing topics such as nutrition, physical activity, and stress management, necessitating a basic understanding of health principles.

Additionally, teachers should be familiar with emergency procedures, including evacuation plans and first aid protocols, and be prepared to guide learners in case of emergencies. Teachers are also responsible for preventing the spread of infectious diseases by educating learners about vaccination, proper hygiene practices, and the importance of staying home when sick. Mental health awareness is emphasized, with teachers expected to recognize signs of mental health issues and provide support or referrals to appropriate resources while fostering a non-judgmental classroom environment.

Teachers should possess knowledge about accommodating learners with special health needs or disabilities, including understanding individualized education plans (IEPs) and providing necessary accommodations. Safety enforcement within the classroom, including rules related to equipment and materials, is crucial. Overall, the paper underscores the importance of teachers in adult literacy programs being well-informed about creating a safe and healthy learning environment, promoting good health practices, and addressing the specific needs of adult learners to support both learning and overall well-being (UNESCO, 2016). In the realm of adult education, creating an effective and supportive learning environment is crucial for the success and well-being of learners. Beyond the traditional focus on academic content, educators must recognize the significance of emotional, social, and physical factors in fostering a conducive learning atmosphere. This study explores the pivotal role of teachers in possessing knowledge related to emotional safety, social health, and physical well-being, emphasizing how this knowledge contributes to the comfort and success of adult learners in educational programs.

Teachers with a deep understanding of emotional intelligence can create a safe and supportive healthy learning environment. Emotional intelligence involves recognizing, understanding, and managing one's emotions and the emotions of others (Goleman, 2015). By being attuned to the emotional needs of adult learners, teachers can establish trust and rapport, creating an atmosphere where learners feel comfortable expressing themselves without fear of judgment or criticism. In the same vein, Teachers who understand the importance of social connections can facilitate community building within the learning environment. Social interactions among adult learners promote a sense of belonging and camaraderie, which positively impacts motivation and overall well-being (Bandura, 2017). Teachers can



incorporate collaborative activities, group discussions, and team projects to encourage social interactions among learners. Teachers knowledgeable about the impact of physical surroundings on learning can create a conducive physical health environment. Considering factors such as seating arrangements, lighting and ventilation contributes to the comfort and well-being of adult learners (Heschong, 2018). An ergonomic learning environment minimizes physical discomfort, promoting a positive learning experience.

Statement of the Problem

Adult literacy centers are confronted with numerous challenges that has to do with the environment such as poor sitting arrangement, poor ventilation, un-conducive environment and poor instructional material by the facilitators and many more. And in today's educational landscape, teachers play a multifaceted role that goes beyond the traditional scope of imparting academic knowledge. They are integral to the creation of a comprehensive learning environment that fosters the overall well-being of students. This study seeks to delve into the depth of teachers' awareness and comprehension concerning the impact of emotional safety, a friendly atmosphere, social health, and physical well-being on students' learning journeys. The academic performance of adult learners enrolled in adult literacy programs in Oshimili South Local Government Area is significantly impacted by various factors, with emotional safety, social health environment, and physical health environment emerging as key contributors to negative outcomes. The absence of emotional safety creates a challenging learning atmosphere for adult learners, hindering their ability to engage effectively in educational activities. Additionally, a compromised social health environment, characterized by inadequate support systems and interpersonal relationships, further hampers the academic progress of these learners. The physical health environment, encompassing factors such as accessibility to healthcare facilities and overall well-being, also plays a detrimental role in the educational journey of adult learners.

These three interconnected elements emotional safety, social health environment, and physical health environment collectively create barriers that impede the optimal academic performance of adult learners in the Oshimili South Local Government Area's adult literacy program. Addressing these challenges is crucial for fostering a conducive learning environment that nurtures the educational growth and success of adult learners in this region. Initiatives aimed at enhancing emotional well-being, improving social support structures, and ensuring a healthy physical environment are imperative for unlocking the full potential of adult learners in their pursuit of literacy and education. Therefore, the focus of this study is to evaluate teacher's knowledge on the challenges and influence of school health environment on academic performance of adult learners in adult literacy programmes in Oshimili South Local Government Area of Delta State.

Purpose of the Study

The objective of this study is to evaluate teacher's knowledge on the challenges and influence of school health environment on academic performance of adult learners in adult literacy programmes in Oshimili South Local Government Area of Delta State. Specifically, the study aim to:

1. Examine Teachers' knowledge on the influence of physical and emotional safety environment on learners' academic performance in adult literacy program in Oshimili South Local Government area, of Delta State.
2. Determine the level of teachers' awareness of the influence of social health environment on adult learners learning experiences in adult literacy program in Oshimili South Local Government area, of Delta State.
3. Find out teachers' perception of the challenges facing adult literacy centers in Oshimili South Local Government area, of Delta State.

Research Questions

The following research questions guided the study:

1. What are teachers knowledge of the influence of physical and emotional safety environment on learner's' academic performance in adult literacy program in Oshimili South Local Government area, of Delta State?
2. What is the level of teachers' awareness regarding the influence of social health environment on adult learners learning experiences in adult literacy program in Oshimili South Local Government area, of Delta State?
3. How do teachers' perceive the challenges facing adult literacy centers in Oshimili South Local Government area, of Delta State?

Methodology of Result and Discussion of Results

A survey research design was adopted for the study. The population comprised of adult facilitators in adult literacy centers in Oshimili south local Government area of Delta State, which were a eighteen (18) in numbers from the only functional center as at the time of this research. Purposive sampling technique was adopted to select the sample for the study and due to the limit size of the population, the entire number was used. Three research questions guided the study and a self structured questionnaire was used titled, teacher's knowledge on the challenges and influence of school health environment on academic performance of adult learners in adult literacy programmes in Oshimili South Local Government Area of Delta State. The instrument was validated by two experts from the department of measurement and evaluation and adult education respectively. After proper scrutiny, necessary correction was made and the corrections were effected before the final versions of the instrument were printed. The instrument comprised of three sections, A-C. The instrument was structured on 4-point rating scale of strongly agree (SD), agree (A), disagree (D), strongly disagree (SD). Data generated were analyzed using Mean and

Standard Deviation. The level of agreement to each questionnaire was determined based on the midpoint for the scale, which is 2.50. Mean score of 2.50 and above were taken as agree; while mean scores below 2.50 were taken as disagree.

Results

Research Question One what are teachers knowledge of the influence of physical and emotional safety environment ton leaner's' academic performance in adult literacy program in Oshimili South Local Government area, of Delta State?

Teachers' knowledge of the influence of physical and emotional safety environment on learners' academic performance in adult literacy program in Oshimili South Local Government area, of Delta State.

Table1: *Mean and Standard Deviationof Teachers' knowledge of physical and emotional safety environment on leaner's academic performance in adult literacy program in Oshimili South Local Government area, of Delta State*

S/N	Statement	Mean X	S.D	Remark
1.	Emotional safetyof the adult learners and the need to create a sufficient space where learners feel comfortable and respected promote learning.		0.81	Agree
2.	Safe environment promote academic achievement of learners in adult literacy programme.		0.98	Agree
3.	Good student-teacher relationships positively influence learners attitude and academic performance		0.67	Agree
4.	Creating emotionally stable environment through encouragement and concern for adult learning promotes learners academic achievement		0.87	Agree
5.	Effective communication is crucial in fostering emotional safety of adult learners and promotes learners academic performance		0.65	Agree
Cluster mean score		3.53	0.79	Agree

Source: Field Survey Data. 2023. N =18

The findings in Table 1 reveal a positive perception among teachers regarding the importance of emotional and physical safety in adult literacy programs. The mean scores for statements related to creating a supportive learning environment, the positive impact of teacher-student relationships, and the awareness of learners' emotional needs all fall within the "Agree" range. Overall, the cluster mean score is 3.53, indicating a reasonably high level of agreement among teachers. The standard deviation values suggest a moderate level of variability in responses but affirm a consensus on the significance of emotional safety.

Research Question Two: What is the level of teachers' awareness regarding the influence of social health environment on adult learners learning experiences in adult literacy program?

Table 2: Mean and Standard Deviation of Teachers' Awareness Regarding the Influence of the Social Health Environment on Adult Learners Learning Experiences in Adult Literacy Program

S/N	Statement	Mean x	S.D	Remark
6.	Social health environment such as, interaction, appropriate language, good listening skills and humility in the learning community promote learning in adult literacy centers	3.67	0.75	Agree
7.	Positive social interactions contribute to adult learners' emotional well-being, motivation and promote academic achievement.	3.68	0.55	Agree
8.	Teachers have awareness of the impact of social dynamics on adult learners to foster a positive and inclusive atmosphere.	3.2	0.73	Agree
9.	Cultural competence is essential for teachers in shaping the social health environment for diverse adult learners.	2.89	0.91	Agree
10.	Teachers' awareness of the social health environment is essential for creating a positive and supportive atmosphere in adult literacy programme.	2.89	0.88	Agree
Cluster Mean Score		3.19	0.76	

Source: Field Survey Data, 2023. N = 18

The findings in Table 2 highlight positive perceptions among teachers regarding the influence of the social health environment on adult learners' experiences in adult literacy programs. Teachers generally agree on the definition of the social health environment, recognizing it as encompassing social interactions, relationships, and the overall atmosphere in the learning community. The importance of positive social interactions is emphasized, with teachers acknowledging their contributions to adult learners' emotional well-being, motivation, and persistence. Additionally, there is recognition of the need for teachers to be aware of the impact of social dynamics to foster a positive and inclusive atmosphere. Cultural competence is deemed essential for shaping the social health environment for diverse adult learners. Although there is some variability in responses, reflected in standard deviation values ranging from 0.55 to 0.91, the overall cluster mean score of 3.19 indicates a generally positive consensus among teachers. Therefore, findings underscore the significance of teachers' awareness of social dynamics in creating a positive and supportive atmosphere in adult literacy programs, thereby enhancing the overall learning experiences of adult learners.

Research Question Three: How do teachers' perceive the challenges facing adult literacy centers in Oshimili South Local Government area, of Delta State?

Table 3: Mean and Standard Deviation of the Teachers' Perceptions of the challenges facing adult literacy centers in Oshimili South Local Government area, of Delta State.

S/N	Statement	Mean x	S.D	Remarks
11.	Adult literacy centers environment such as classroom design, lighting, ventilation, and overall safety is not encouraging	2.78	0.77	Agree
12.	The centers are not conducive enough to facilitate learning.	2.78	0.94	Agree
13.	Using classrooms that are meant for children to teach adults, with poor seating arrangements that does not enhanced learning outcome of adult learners positively	3.22	0.59	Agree
14.	The unhealthy environment in the centers affect concentration and focus of adult learners negatively	3.44	0.68	Agree
15.	Teachers' perceptions of accommodation for learners with physical disabilities do not encourage participation.	4.00	0.98	Agree
Cluster Mean Score		3.24	0.79	

The findings presented in Table 3 shed light on teachers' perceptions of the challenges faced by learners in adult literacy centers. The data indicates a generally negative perception of teachers regarding the centers. The agreement is observed across various statements, including Adult literacy centers environment such as classroom design, lighting, ventilation, and overall safety that is not encouraging, centers are not conducive enough to facilitate learning, Using classrooms that are meant for children to teach adults, with poor seating arrangements that does not enhanced positive learning outcome of adults, the unhealthy environment in the centers affect concentration and focus of adult learners negatively and Teachers' perceptions of accommodation for learners with physical disabilities that does not encourage participation.

Although there is some variability in responses, with standard deviation values ranging from 0.59 to 0.98, the overall cluster mean score of 3.24 suggests a negative consensus among teachers. In summary, teachers observe the challenges at the centers and emphasizing the need for attention to classroom design and environmental factors to create a conducive and supportive learning environment.

Discussion of Results

The findings of this study are organized and discussed based on the research purpose in relation to the research questions guiding the study.



The finding of table one revealed that the respondents are in agreement that teachers in adult literacy programs show a generally positive awareness of the importance of emotional safety. They agree that creating a supportive and respectful space, positive teacher-student relationships, and awareness of learners' emotional needs are crucial for effective learning in order to promote academic performance of adult learners. Awareness of emotional safety may be challenged by various factors, including diverse learner backgrounds and limited resources. Teachers must be cognizant of potential barriers and proactively implement strategies to address emotional safety concerns. For instance, collaborative professional development opportunities that focus on culturally responsive teaching and trauma-informed practices can enhance teachers' awareness and competence in creating emotionally safe learning environments.

The finding of table two revealed that the respondents are in agreement that teachers generally agree on the definition of the social health environment, recognizing it as encompassing social interactions, relationships, and the overall atmosphere in the learning community. The importance of positive social interactions is emphasized, with teachers acknowledging their contributions to adult learners' emotional well-being, motivation, and persistence. Additionally, there is recognition of the need for teachers to be aware of the impact of social dynamics to foster a positive and inclusive atmosphere. Cultural competence is deemed essential for shaping the social health environment for diverse adult learners. This is in line with Brockett and Hiemstra (2021) who emphasizes that adult educators should be attuned to the social aspects of learning, acknowledging the importance of creating a supportive community that values diversity and encourages collaboration. Teachers' cultural competence is particularly relevant in shaping the social health environment for adult learners from diverse backgrounds. Being aware of and responsive to learners' cultural identities contributes to a sense of inclusivity and fosters a supportive community.

The finding of table three revealed that adult literacy centers in Oshimili South Local Government Area of Delta State are confronted with physical health environmental challenges such as, poor accommodation, poor lighting and sitting arrangements. These findings imply that teachers in adult literacy programs recognize and value the role of physical health environment in facilitating effective learning experiences. The results may serve as a foundation for further exploration and the development of strategies to enhance emotional safety awareness among educators, ultimately contributing to the creation of more supportive and conducive learning environments for adult learners in literacy programs. The physical health environment also intersects with the overall well-being of adult learners. Teachers' perceptions of the importance of factors like air quality, access to natural light, and ergonomic seating can influence the overall health of adult learners, subsequently impacting their ability to focus and engage in learning activities (Heschong, 2018).

Conclusion

In conclusion, the findings of the study revealed that teachers recognize the importance of emotional safety in adult literacy programs; teachers understand the impact of the social health environment on adult learners, emphasizing positive social interactions and cultural competence. The study also revealed Teachers perceived challenges facing adult learners at the literacy centers, emphasizing factors like classroom design and lighting. Based on this findings recommendations were made.

Recommendations

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

1. Adult education teachers' should continue to foster emotionally safe environments by actively engaging in positive teacher-student relationships and promoting a supportive and respectful atmosphere.
2. Adult literacy coordinator should provide opportunities for ongoing professional development for teachers, focusing on emotional intelligence, cultural competence, and effective communication strategies.
3. Governments' should give significant consideration to adult literacy centers by allocating sufficient fund and formulating policies that support the creation of emotionally safe and conducive environments in adult education settings.

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The Importance of Ethno-Mathematics into Teaching Probability in Delta State

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Abstract

The teaching of probability is a fundamental aspect of mathematics education, aimed at developing students' understanding of uncertainty, chance, and statistical reasoning. This study addresses the need for integrating ethno-mathematics into teaching probability in Nigeria, recognizing the potential benefits of a culturally inclusive approach. The study adopted a descriptive survey research design. Nineteen teachers responded to the online survey, which formed the sample size. The instrument used for data collection was a structured questionnaire titled "Integrating Ethno-Mathematics into Probability Instruction Questionnaire (IEPIQ). The instrument was validated by experts, in mathematics education and measurement and evaluation. The grand mean of 2.63 indicates an overall agreement that there are significant challenges associated with the integration of ethno-mathematics into probability teaching, primarily related to time constraints, balancing with other standards, and curriculum overload. The respondents generally agree on the effectiveness of several strategies: Strong agreement among educators on incorporating ethno mathematics into probability teaching through collaboration, professional development, curriculum flexibility, and culturally appropriate resources. These strategies not only enrich mathematics instruction with cultural diversity but also promote inclusivity and deeper engagement among students, aligning with broader educational goals of enhancing learning experiences. Addressing these challenges through collaboration and professional development can enhance mathematics education by embracing Nigeria's diverse cultural identities, thereby improving student engagement and learning outcomes.

Introduction

In contemporary education, the integration of ethno-mathematics into the teaching of mathematical concepts, such as probability, offers a unique and enriching approach. Ethno-mathematics, a term coined by the Brazilian mathematician Ubiratan D'Ambrosio in 1977, refers to studying the relationship between mathematics and culture. It recognizes that mathematical practices are deeply embedded in the cultural activities of different societies and that these practices can provide valuable insights into the teaching and learning of mathematics. Probability on the other hand is the measure of the likelihood that a particular event will occur, often expressed as a number between 0 (impossibility) and 1 (certainty) (Ross,



2014). In ethno-mathematics, probability can be understood through cultural practices and traditional knowledge systems. Different cultures have developed unique ways of dealing with uncertainty and chance, often embedded in games, rituals, and decision-making processes.

Practical strategies for integrating ethno-mathematics into probability teaching in Nigeria include utilizing cultural resources, celebrating traditions, and incorporating traditional practices from various Nigerian cultures. Educators can make probability education more engaging and relevant by using cultural artefacts like traditional games (e.g., "Ayo" and "Ludo") to illustrate probabilistic concepts in relatable ways. For instance, traditional African games like "Ayo," a mancala-type game, involve strategic thinking and probabilistic reasoning, offering a culturally relevant way to explore probability concepts. "Ayo" involves moving seeds or beads across a board with multiple pits. Players sow seeds and capture opponents' seeds based on specific rules, representing opportunities for students to analyze possible outcomes and calculate the probability of certain moves leading to a win. These games demonstrate randomness and strategic decision-making while reinforcing mathematical principles and celebrating Nigerian heritage (Fasasi, 2017). Incorporating cultural celebrations and practices into lessons also shows how mathematical concepts are embedded in traditions, engaging students and enhancing understanding. For example, the New Yam Festival is an annual celebration in Igbo culture, signifying the beginning of the harvest season. During the festival, various ceremonies, including the menu (masquerade) dance, occur. Students can explore the probability of specific events occurring during the festival, such as the likelihood of a specific masquerade appearing or a particular dance sequence being performed. Additionally, exploring probabilistic elements in Nigerian folktales connects students to their cultural identity (Adeleke & Appah, 2019). Encouraging discussions on how different Nigerian communities approach probability fosters a collaborative learning environment that values diverse perspectives, broadening students' understanding and promoting cultural appreciation (Achor & Agbo-Egwu, 2017).

Integrating ethno-mathematics into teaching probability in Nigeria faces challenges such as the scarcity of culturally appropriate teaching materials and the need for specialized teacher training (Fasasi, 2017). This can be addressed by developing a repository of ethno-mathematics resources tailored to Nigerian contexts (Aitanke, 2018) and fostering collaborative efforts between educators, researchers, and policymakers (Adedeji, 2020). Professional development programs focused on ethno-mathematics can equip teachers with the necessary skills and knowledge (Okuneye, 2021), and ongoing dialogue with stakeholders can help overcome resistance (Akinola, 2017). There is also resistance among educators and administrators towards non-Western mathematical approaches due to unfamiliarity and perceived bias in favour of Western methods (Ayodele, 2019; Aitanke, 2018;

Adedeji, 2020). Professional development programs that showcase successful case studies and practical applications can help educators overcome these biases (Okuneye, 2021). Fostering an inclusive educational environment promotes broader acceptance of different mathematical paradigms (Akinola, 2017).

Supporting teachers through training, workshops, and collaborative projects on the intersection of mathematics and culture can enhance their ability to create culturally responsive lesson plans (Adeleke & Appah, 2019). Establishing professional learning communities where teachers share best practices further supports the effective integration of ethno-mathematics, leading to a more inclusive and engaging mathematics education (Olosunde, 2018; Ajai & Imoko, 2020).

Research has shown that when students see their cultural heritage reflected in the curriculum, they are more likely to engage with the material and develop a positive attitude towards learning (Achor & Agbo-Egwu, 2015). This is particularly important in a diverse country like Nigeria, where students come from various ethnic and cultural backgrounds. By acknowledging and valuing these cultural contributions, educators can foster a more inclusive classroom environment that empowers through culturally all students and promotes a deeper understanding of mathematical concepts. Hence; this study aims to integrate ethno-mathematics into teaching probability in Nigeria, enhancing student engagement relevant practices. It also seeks to identify challenges and propose solutions for effective implementation.

Statement of the Problem

The teaching of probability is a fundamental aspect of mathematics education, aimed at developing students' understanding of uncertainty, chance, and statistical reasoning. However, traditional approaches often overlook the cultural diversity and relevance that ethno-mathematics can offer. These conventional methods fail to connect with students' cultural backgrounds, experiences, and everyday contexts, leading to disengagement and limited understanding of probability concepts. Consequently, students may struggle to see the relevance and applicability of these concepts in their own lives. This study addresses the need for integrating ethno-mathematics into the teaching of probability, recognizing the potential benefits of a culturally inclusive approach.

Research Questions

The following questions guided the study.

1. What are the strategies for integrating ethno-mathematics in teaching probability?
2. What are the challenges associated with the integration of ethno-mathematics in teaching probability?
3. What are the ways of integrating ethno-mathematics in teaching probability?

Methodology

This study adopted a descriptive survey research design. Three research questions were posed to guide the study. The population of the study comprised of Mathematics Association of Nigeria (MAN) Asaba, Delta State Nigeria chapter. Nineteen teachers responded to the online survey, which formed the sample size. The instrument used for data collection was a structured questionnaire titled "Integrating Ethno-mathematics into Probability Instruction Questionnaire (IEPIQ). The questionnaire is a 4-point Likert scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with assigned normal values of 4, 3, 2, and 1 respectively. It consists of 15 items of questions that solicited information about the research questions for the study. The instrument was validated by experts, in mathematics education and measurement and evaluation. Data collected were analyzed using mean and standard deviation to answer the research questions for the study a criterion mark of 2.5 was adopted for decision-making. However, a calculated mean greater than or equal to 2.5 is assumed to be high (agree) while a calculated mean less than 2.5 is assumed to be low (disagree)

Results

Research Question One: What are the strategies for integrating ethno-mathematics in teaching probability?

Table 1: Mean and Standard deviation on the strategies of integrating ethno-mathematic

S/N	Items	Mean	S.D	Remark
1.	By integrating cultural resources (traditional games, puzzles, music, and rhythms) into probability lesson	3.80	.632	Agree
2.	Incorporating cultural celebration or festival that involves probability thinking	3.50	.707	Agree
3.	Collaborating with students to identify ethnomathematics practice in probability	3.50	.527	Agree
4.	Using traditional practices from different cultures to teach probability concepts	3.40	.516	Agree
5.	Using digital technology does not provide virtual cultural experiences related to probability	2.30	1.160	Disagree
Grand Mean		3.30		Agree

Table 1 provides insights into the strategies for integrating ethno-mathematics into the teaching of probability, showcasing the mean scores and standard deviations of various strategies for integrating ethno-mathematics into probability teaching. Strongly supported methods include integrating cultural resources (Mean = 3.80, SD = 0.632), incorporating cultural celebrations (Mean = 3.50, SD = 0.707), and collaborating with students to identify ethno-mathematics practices (Mean = 3.50, SD = 0.527). Using traditional practices from different cultures (Mean = 3.40, SD =

0.516) is also endorsed. However, using digital technology for virtual cultural experiences received lower support (Mean = 2.30, SD = 1.160). The grand mean of 3.30 indicates that strategies of integrating ethno-mathematics into probability lessons including cultural resources such as traditional games, puzzles, music, rhythms, and cultural and festival celebrations will enhance students' engagement and understanding of probability concepts through meaningful connections to cultural contexts

Research Question Two: What are the challenges associated with the integration of ethno-mathematics in teaching probability?

Table 2: Mean and Standard deviation on the challenges associated with the integration of ethno-mathematics

S/N	Items	Mean	S.D	Remark
6.	Lack of available instructional materials that incorporate ethnomathematics in probability education	1.00	.000	Disagree
7.	Lack of time in the curriculum to fully explore ethnomathematics concept in probability instruction	3.10	.738	Agree
8.	Balancing the integration of ethnomathematics with other concepts and standards	2.90	.738	Agree
9.	The curriculum is choked up will integrating ethnomathematics into probability instruction be cumbersome	3.50	.527	Agree
Grand Mean		2.63		Agree

Table 2 presents the mean and standard deviation of responses regarding the challenges associated with integrating ethno-mathematics into the teaching of probability. Items 7, 8, and 9 had mean score values of 3.10, 2.90, and 3.50 respectively which are above the cut-off point of 2.50. Item 6 had a mean score of 1.00 which is below the cut-off point of 2.50. The grand mean of 2.63 indicates an overall agreement that there are significant challenges in integrating ethno-mathematics into probability teaching, primarily related to time constraints, balancing with other standards, and curriculum overload. However, the availability of instructional materials is not seen as a major issue. mean of 2.63 indicates an overall agreement that there are significant challenges in integrating ethno-mathematics into probability teaching, primarily related to time constraints, balancing with other standards, and curriculum overload. However, the availability of instructional materials is not seen as a major issue.

Research Question Three: What are the ways of integrating ethno-mathematics in teaching probability?

Table 3: Mean and Standard deviation on ways of integrating ethnomathematics in teaching probability

S/N	Items	Mean	S.D	Remark
10.	Collaborating with educators from diverse cultural backgrounds to co-create ethnomathematics examples and problem-solving task	3.60	.516	Agree
11.	Providing professional development workshop on integrating ethnomathematics in probability instruction	3.30	.483	Agree
12.	Incorporating ethnomathematics modules programs to enhance cultural sensitivity	3.50	.527	Agree
13.	Allowing flexibility in the curriculum to accommodate ethnomathematics content in probability instruction	3.40	.516	Agree
14.	Providing resources and guidelines in culturally appropriate ways to integrate ethnomathematics	3.40	.516	Agree
15.	Encouraging open discussion and reflections on cultural perspectives in probability education	2.90	.876	Agree
Grand Mean		3.35		Agree

Table 3 presents the mean and standard deviation of responses to items on integrating ethno-mathematics in teaching probability. Table 3 presents the mean and standard deviation of responses to items on integrating ethno-mathematics in teaching probability. The respondents generally agree on the effectiveness of several strategies: Strong agreement among educators on integrating ethnomathematics into probability teaching through collaboration (Mean = 3.60, SD = 0.516), professional development (Mean = 3.30, SD = 0.483), curriculum flexibility (Mean = 3.40, SD = 0.516), and culturally appropriate resources (Mean = 3.40, SD = 0.516). However, there's more variability in opinions about encouraging open discussions on cultural perspectives (Mean = 2.90, SD = 0.876). The grand mean of 3.35 across all items indicates a general agreement among respondents that integrating ethno-mathematics into the teaching of probability is beneficial and important.

Discussion of Results

Table 1 reveals effective strategies for integrating ethno-mathematics into probability instruction, utilizing cultural resources such as traditional games, music, and festival celebrations. Fasasi (2017) supports using traditional games like "Ayo" to enhance probabilistic reasoning by engaging students in strategic thinking and decision-making while Adeleke & Appah (2019) extend this by advocating for the integration of cultural celebrations like the New Yam Festival, where probabilistic elements can be explored through traditional rituals and practices. Achor & Agbo-Egwu (2017) emphasize collaborative approaches to identify and incorporate ethno-mathematical practices, fostering a participatory learning environment that values



diverse perspectives. These strategies not only enrich mathematics instruction with cultural diversity but also promote inclusivity and deeper engagement among students, aligning with broader educational goals of enhancing learning experiences. Table 2 highlights challenges in integrating ethno-mathematics into probability teaching, focusing on time constraints, balancing with other standards, and curriculum overload, while instructional material availability is less of an issue. Adedeji (2020) stresses the development of specialized resources and collaborative efforts among educators, researchers, and policymakers to create ethno-mathematics materials tailored to Nigerian contexts. Okuneye (2021) advocates for comprehensive teacher training and ongoing professional development to effectively integrate cultural diversity. Aitanke (2018) underscores the need for curriculum adaptation to seamlessly incorporate diverse cultural perspectives without compromising educational objectives, aiming to enhance inclusivity in mathematics education in Nigeria.

Table 3 outlines key strategies for integrating ethno-mathematics into probability education, including collaboration with diverse educators, professional development workshops, ethno-mathematics module incorporation, curriculum flexibility, provision of culturally appropriate resources, and fostering cultural discussions. These methods complement practical approaches discussed earlier, such as using cultural artefacts like traditional games ("Ayo") and celebrations (New Yam Festival) to enrich learning and connect mathematical concepts with Nigerian cultural heritage (Fasasi, 2017; Adeleke & Appah, 2019). However, challenges like the lack of culturally relevant materials and insufficient teacher training underscore the need for effective implementation strategies (Fasasi, 2017; Adedeji, 2020; Okuneye, 2021). Addressing these challenges through collaboration and professional development can enhance mathematics education by embracing Nigeria's diverse cultural identities, thereby improving student engagement and learning outcomes.

Conclusion

The integration of ethno-mathematics into the teaching of probability in secondary schools offers a promising avenue for enhancing both the understanding of probability concepts and the appreciation of diverse cultural perspectives. This approach recognizes that mathematics is not a universal and objective discipline, but rather a human endeavour that is shaped by cultural, historical, and social contexts. By incorporating ethno-mathematics examples, contexts, and narratives into the teaching of probability. However, educators can create a more inclusive and engaging learning environment that resonates with students from various cultural backgrounds.

Recommendation

The following recommendations were made:

1. Teachers need to be aware of their students' cultural backgrounds and use appropriate examples and teaching methods that are relevant to their student's experiences. This fosters cultural awareness and sensitivity, promoting a deeper understanding of the cultural interconnectedness of mathematics and society.
2. Teachers should also be aware of any potential cultural biases that may exist in traditional probability teaching methods and work to address them. This can help students understand that mathematical ideas are not fixed but evolve based on cultural influences.
3. Teachers should encourage students to research and present ethno-mathematics approaches to probability from their cultural backgrounds. This not only empowers students to explore their heritage but also fosters a sense of ownership and relevance in their learning.
4. Government and school owners should provide ongoing professional development opportunities for mathematics teachers to learn about ethno-mathematics and its integration into the curriculum. This ensures that teachers are well-equipped to implement this approach effectively.

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The Use of Internet of things (IoT) in Promoting Science and Technology-based Learning in the Education Sector for Sustainable National Development

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Abstract

In the realm of fourth-generation industrialization, there will be great demand for a skilled workforce. To produce a skilled workforce, we need sustainable education with quality and equity. Conventional ways of delivering and managing education would not fulfil the demands of the fourth industrial revolution (4IR). Disruptive technologies, such as Internet of Things (IoT), have great potential in revolutionizing the current educational setup. Therefore, this paper explores the potential of integrating the Internet of Things (IoT) in the education sector to promote science and technology-based learning for sustainable national development. By leveraging IoT devices and technologies, educational institutions can provide interactive and personalized learning experiences, enable remote learning opportunities, create smart campuses, facilitate hands-on experiments, enhance data analysis and visualization, promote collaboration and project-based learning, and prepare students for future careers in science and technology. The paper emphasizes the role of IoT in driving sustainable national development by empowering students with the skills and knowledge required to address complex challenges and contribute to innovation in science and technology fields and also made some suggestions.

Keywords: *Internet of Things, Education, Science and Technology National Security, sustainable development*

Introduction

The rapid advancements in IoT have provided an opportunity to revolutionize the education sector. By incorporating IoT devices and technologies in classrooms, educational institutions can enhance the learning experience for students, promote engagement and critical thinking, and prepare them for future careers. (Johnson & Smith, 2019). The world we live in has changed dramatically in the previous decade as a result of technology advancements and digitization. Abrupt advances in wireless technologies and digital devices have ushered in a technological revolution all around us. The fourth industrial revolution, (2017) in this scenario, is bringing automation to every aspect of life, including schooling. It is critical to consider



inclusive, equitable, and high-quality education at this stage of development. The digital divide is widening in the sense that the developed part of the world has more resources than the developing world. The only thing which can narrow the gap is sustainable quality education, provided equally to the masses. We must consider how technological advancements can assist in upbringing the world's underprivileged population. To keep the pace with technological advancements and the digital revolution, we have to embark new ways of educational systems. The initiation of education and workforce policies which develop superior talent is one of the five policies identified by the World Economic Forum (2017). One way of narrowing the bridge between developed and developing countries is to reform educational settings by harnessing new technologies to uplift educational systems, therefore providing quality education for sustainable development. Educators can use advanced technologies not only for educational system development but also for developing a skilled workforce for future digital economies. (Benita, Virupaksha, & Wilhelm, (2021) IoT, as one of the disruptive technologies, can play a vital role in enhancing quality of learning experiences and the performance of the learners, supporting teachers' daily work, school building management, school transport systems, and distanced learning provision. The Internet of Things has the potential to provide sustainable quality education and provide solutions for the everyday challenges which education providers and managers face. The Internet of Things can enable equitable, quality education and can play a role in sustainability. Data-driven smart systems will be the cornerstone of the fourth industrial revolution. According to (Georgescu,& Popescu,2015), IoT is the key driving technology for the data-driven smart systems in future. However, there will be challenges related to IoT applications. We showcase how IoT can be applied in educational contexts from school manager's, teacher's, and a learner's perspectives, to create a sustainable smart school and society for sustainable national development.

The Review of Some Related Literature are Discussed Below

Internet of Things

Internet of Things (IoT) can be described as a comprehensive network framework that consist of numerous connected real world things, which depend on sensory, communication, networking and information processing technologies (Li, Xu., Wang,& Wang, (2012). The center technology for IoT is RFID which stands for Radio-Frequency Identification it is a technology used in the internet of things (IoT) to identify and track objects or individuals using radio waves by allowing microchips to transfer identifying data to the reader via wireless medium. Through RFID, objects connected can be analyzed, traced and monitored with RFID tags,(Liqiang, Shouyi, Leibo, Zhen & Shaojun, (2011). Wireless Sensor Networks (WSNs) and their fundamental technology, mainly works on intelligent sensors for sensing and monitoring. The Internet of Things (IoT) is an evolving network of things that communicate between themselves and other internet enabled devices over the



internet, it remotely monitors and controls the physical world (Velumani,2014). Internet of things (IoT) refers to an intelligent network of connected objects for the purpose of communication, actuation, data aggregation and information processing (Ndubuaku, 2015).

The integration of IoT in education has gained significant attention in recent years due to its potential to transform the learning experience and contribute to sustainable national development. Several studies have explored the various applications and benefits of IoT in promoting science and technology-based learning in the education sector. Johnson & Smith (2019) discussed the role of IoT in transforming education and highlight the opportunities and challenges associated with its implementation. They emphasize that IoT devices and technologies can enhance student engagement, provide personalized learning experiences, and enable real-time data analysis. However, issues such as data privacy and security concerns need to be addressed for successful integration. Chen and Jin (2020) conducted a systematic review to explore the transformative potential of IoT technologies in education. They found that IoT devices, such as sensors and wearable's, can enable hands-on experiments, data collection, and analysis, promoting deeper understanding of scientific concepts. The review also highlighted the importance of teacher training and infrastructure development for successful implementation. (Ahubele,& Ugbari (2017). focused on the use of IoT in higher education classrooms. They found that IoT devices can enhance student engagement and collaboration, enable personalized learning, and provide real-time feedback. The review emphasized the need for collaborative partnerships between educational institutions, technology providers, and policymakers to ensure successful implementation. (Atzori, Iera, Morabito,& Nitti, (2012). conducted a comprehensive survey on the use of IoT in education. Their study highlighted the benefits of IoT in promoting active learning, critical thinking, and problem-solving skills in science and technology subjects. The survey also identified challenges such as the high costs of IoT devices and the need for teacher training to effectively integrate IoT in the classroom. Overall, the literature review indicates that IoT has the potential to revolutionize science and technology-based learning in the education sector. It can enhance student engagement, promote hands-on learning experiences, enable real-time data analysis, and foster critical thinking and problem-solving skills. However, there are challenges that need to be addressed, including privacy and security concerns, infrastructure requirements, and teacher training.

Science and Technology and Sustainable National Development

Science is a branch of knowledge that is concerned with the observation and classification of facts and formulation of general truth. Science suggests ideas and technology operationalizes them. Science clarifies and justifies how an objective may be achieved. The "how" is translated into practical realization and from here,



technology takes over and complements science (Williams, 1998). This therefore shows that there is a symbolic relationship between science and technology. Science which is a systematic search for truth provides the basis for technology. Without technology, science becomes impotent, and without science, technology does not exist. However, it is the technology, the application of techniques and not science that leads to increase in production. In the past, science and technology constituted distinct traditions, maintaining separate identity paths of process and activities. But around the 19th century, there was a development of closer relationship between the two. The narrowing of that gap of separate identities culminated in the birth of the concept of science and technology which will help enable the nation to identify potential threats, share information more readily. Nwanegbo and Odigbo, (2013) describes sustainable development as a construct, which envisions development as meeting the needs of a present generation without compromising the needs of a future generation. It implies that while development meets the needs of the present, it does not compromise the ability of a future generation in order to meet their own needs. Scholars have identified strong links between security and sustainable development since the cold war ended.

Ayodele, (2007), broadly defined sustainable development as the ability of the economy to support the needs of the people of a country over a time, taking into consideration the economic, social and ecological constraints of the country. (Uwabueze & Ozionko (2011) Sustainable development leads to fulfilment of societal ideas considered relevant to the needs and aspirations of the society. Science and technology have been central in the progress and development of virtually all the nations of the world. It has contributed immensely in all sector of the economy. Science and technology are intimately connected with development because; they have historical record of bringing advances that have led to healthier, longer, wealthier and more productive lives and they are key ingredients to solutions to the most serious poverty alleviation and economic development challenges that we currently face and are likely to face in the future. The many ways in which science and technology impact poverty alleviation across various sectors and economic growth merit attention

Applications of IoT in Education

Some of the many applications of IoT in education include:

1. **Tracking Devices:** It's important to monitor your students' whereabouts to avoid risks. Since there could be a large number of students, you can't possibly monitor each one of them separately by manual means. It's where you can leverage IoT solutions for education. Tracking systems such as smart ID cards, school bus trackers, attendance trackers, parking sensors, etc. Can help you there.

2. **Smart Boards and Textbooks:** Interactive digital media such as smart whiteboards, AR, VR, etc. Help educators make learning engaging and immersive. Using these systems will also help you collect and analyze data in the classroom or outside at any time you want. By analyzing this data, they can understand the gaps in their educational process and find ways to improve the learning process as well as results. They can even personalize learning using this data. Similarly, digital notebooks enable students to access a large library of content easily which can frequently be updated to suit present needs. This allows students and parents to save money and is an eco-friendly alternative too.
3. **Security Systems:** Maintaining security in your institutional premises is undoubtedly necessary. Although you could keep security personnel, digital security systems are still necessary to be safe from advanced threats. IoT-enabled security systems such as wireless door locks face recognition devices, surveillance cameras, etc. Will help you provide enhanced security not only for your students but also teachers and staff.
4. **Research and Study Programs:** Institutions can leverage automated and advanced IoT systems in their research and study programs dedicated to fields such as engineering, medicine, etc. It will not only provide the students the opportunity to learn the concepts with advanced technologies but also empower the instructors. They can also utilize the power of AI and ML to connect databases, gain insights, and analyze researched data to accelerate innovation.
5. **Accommodating with Disability:** IoT can be helpful for students with certain disabilities such as difficulty in seeing or hearing. For example, hearing-impaired students can use connected gloves with a tablet for translating sign language into speech and turning sound into text. Similarly, students with difficulty in seeing can utilize IoT devices for education like a smart stick, a headset, and a mobile app to identify objects and walk home safely.

Benefits IoT Brings in Education

Some of the many benefits of IoT in education include:

1. **Increase Management Efficiency:** It requires a lot of effort and paperwork to manage the processes of an educational institution. You will need to properly distribute funds, track supply management, maintain student records and their academic progress, and so on. The use of IoT in education enables institutions to perform management tasks faster and risk-free by looking at organized data and taking insights from it to shape decisions. It helps keep everyone in the loop from students and parents, to the school management, staff, and teachers.

2. **Improved Accessibility:** Today, education is not confined to the walls of an institution. Instead, anyone from any part of the world can connect and seek education from anywhere. IoT is basically a system that connects devices and physical objects to the internet so that users can accomplish their tasks. This global nature of IoT-enabled systems allows educators to deliver education to anyone and improve their teaching standards. Educators can connect with each other to shape their tips and tricks. Meanwhile, the course accessibility becomes easier and faster for students. They can also connect with other students and learn in groups, all virtually.
3. **Enhanced Safety:** Educational institutions need security for their students and staff as well as their infrastructure and systems. Manual ways are usually not enough in this advanced age since attackers have become smarter. Using the internet of things in education in the form of systems such as tracking devices, video monitoring tools, vape sensors, surveillance cameras, and other smart systems will help you keep track of every activity 24/7 and secure your students, staff, and infrastructure. This provides a sense of safety not only to students and teachers but the parents, promoting a safe learning environment for all.

Impart of IoT in Education in Promoting Sustainable National Development

The Internet of Things (IoT) has the potential to revolutionize the education sector by promoting science and technology-based learning for sustainable national development. The integration of IoT in promoting science and technology-based learning in the education sector has the potential to drive sustainable national development. By empowering students with practical skills, critical thinking abilities, and access to cutting-edge technologies, IoT can pave the way for a future workforce that is well-equipped to tackle complex challenges and drive innovation in science and technology.

Here are some ways in which IoT can be used in education:

1. **Interactive and Personalized Learning:** IoT devices such as smart boards, tablets, and wearables can enable interactive and personalized learning experiences. Students can access real-time data, collaborate with their peers, and receive personalized feedback, allowing them to have a hands-on approach to science and technology subjects.
2. **Remote Learning:** IoT can enable remote learning opportunities, especially in underserved areas. IoT devices can be used to create virtual classrooms, allowing students to access educational resources, lectures, and experiments from anywhere. This promotes inclusive and sustainable education for all, regardless of geographical location.
3. **Hands-On Experiments:** IoT devices can enable students to conduct hands-

- on experiments in various scientific fields. For example, they can use IoT-enabled sensors and tools to collect real-time data during experiments, analyze it, and draw conclusions. This promotes critical thinking, problem-solving skills, and a deeper understanding of scientific concepts.
4. **Data Analysis and Visualization:** IoT can provide students with access to large amounts of data that can be analyzed and visualized in real-time. This allows them to identify patterns, make data-driven decisions, and develop skills in data science and analytics; Science and technology-based learning can thus be more engaging and practical.
 5. **Collaboration and Project-Based Learning:** IoT devices can facilitate collaboration among students, enabling them to work on projects and solve real-world problems together. This promotes teamwork, creativity, and innovation, which are essential for sustainable national development.
 6. **Career Readiness:** The use of IoT in education can better prepare students for careers in science, technology, engineering, and mathematics (STEM) fields. By gaining hands-on experience with IoT devices and technologies, students can develop the skills and knowledge required for the jobs of the future, contributing to the growth of the nation's technology sector.

Challenges facing Implementation of IoT in Nigeria

Despite the many benefits of IoT in education, there are certain challenges too that the management and officials, school owners individuals and government must understand and put in efforts to overcome them. So, if you are implementing IoT in your institutions, you may have to face these challenges.

1. **High Costs:** Implementing IoT in an educational institution involves high costs toward systems, devices, software, hardware, and power to run them. Whether it's deploying them for the first time on your premises or maintaining them periodically, it will require expert hands, which again is costly. You may have to hire a skilled professional or tech team trained in data science and management, installation and maintenance, software development, security professionals, and so on. This becomes a big challenge for small-sized institutions and public-funded schools to install.
2. **Data Security and Privacy:** Data security and privacy are common but serious concerns for organizations. IoT devices collect and process huge volumes of data, which can lure in cyber threats such as data stealing, phishing attacks, man-in-the-middle attacks, ransom ware, and so on. So, if you don't use advanced, necessary technologies to keep your data private and secure, it can become disastrous for your institution in terms of money, fame, and student and parent trust in your institution.

3. **Data Storage Issues:** IoT involves a large amount of data collected which must be stored and organized properly. But many a time, institutions rely on on-premises storage systems that are not adequate and outdated too. It not only makes data unstable but also risky to get exposed or lost in an attack or natural disaster.

Conclusion

IoT has the potential to revolutionize the education sector by promoting science and technology-based learning. By integrating IoT devices and technologies, educational institutions can enhance the learning experience, promote engagement, and prepare students for future careers. The use of IoT in education contributes to sustainable national development by enabling innovation, fostering critical thinking skills, and ensuring students are well-equipped to address complex challenges in science and technology.

Suggestions

1. The government and Organizations should develop new and improved ways to make IoT-enabled systems more affordable and easier to implement. So, that institutions, private school owners and individuals will be able to afford it.
2. Security policies and technologies should be put in place to secure data from attackers. You must also spread awareness about the same among staff and students so they never fall prey to scams. Also, if children are involved, it's essential to secure collected data and ensure the stakeholders' privacy. Educational institutions and parents must get assurance from the IoT service provider regarding the systems they will be using and understand effectively apply security and privacy measures.
3. Internet-connected systems and cloud-based storage systems, should be used so you can store a massive amount of data. You can also keep multiple copies at multiple places to ensure your data is safe even if one facility is down.

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The Role of Mobile Technology in Promoting Digital Literacy and 21st Century Skills for Sustainable National Development

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Abstract

This paper explores the significant role of mobile technology in promoting digital literacy and 21st-century skills for sustainable national development. With the rapid advancement of mobile technology, individuals and communities are better equipped to access digital resources and engage in learning opportunities. This paper explores the meaning of digital literacy and 21st-century skills, the importance of digital literacy and 21st-century skills, role of mobile technology in promoting digital literacy and 21st-century skills for sustainable national development and recommendations were drawn that through Effective Integration of Mobile Technology to Promote Digital Literacy and 21st Century Skills, Sustainable National Development can be Achieved such as building infrastructure development to ensure access to reliable, affordable, and high-speed internet connectivity across the nation, especially in rural and underserved areas.

Keywords: Mobile technology, digital literacy, 21st-century smkills, national development, sustainable development

Introduction

In the rapidly advancing digital age, mobile technology has emerged as a powerful tool for promoting digital literacy and 21st-century skills. With its widespread availability and affordability, mobile technology has the potential to bridge the digital divide and empower individuals, communities, and nations towards sustainable national development.

Mobile Technology and its integration in the 21st Century

Mobile technology has become an integral part of our daily lives, influencing the way we communicate, access information, and engage with the world around us. With the rise of mobile devices such as smartphones and tablets, there has been a growing interest in leveraging these technologies for promoting digital literacy and 21st century skills for sustainable national development. With the increasing penetration of mobile devices across both developed and developing nations, mobile technology has significantly expanded access to digital resources, facilitating the acquisition of knowledge and skills that were previously limited to certain geographic or socio-economic groups. Mobile devices, such as smartphones and



tablets, provide users with opportunities for anytime, anywhere access to diverse online content, applications, and educational resources. These devices empower individuals to engage in self-directed learning, explore digital platforms, and participate in collaborative, interactive initiatives that foster the development of critical digital competencies and 21st-century skills. In addition, mobile technology has revolutionized the educational landscape by enabling personalized, learner-centered approaches that cater to individual needs and learning styles. Mobile applications and online platforms offer adaptive learning experiences, interactive tutorials, and gamified learning environments, tailoring education to the unique needs and interests of each learner. Through personalized learning experiences, learners can acquire digital skills, such as information retrieval, evaluation, and synthesis, while also cultivating essential 21st-century skills like creativity, adaptability, and digital citizenship.

It is notable that the benefits of mobile technology extend beyond fostering digital literacy and 21st century skills at the individual level. Mobile devices and their accompanying technologies have proven to be invaluable tools in enhancing educational systems, bridging educational disparities, and supporting sustainable national development.

The Concept of Digital Literacy

Digital literacy refers to the ability to access, evaluate, and use digital information effectively, utilizing various digital technologies for communication, information retrieval, and problem-solving (Van Deursen & Van Dijk, 2019). On the other hand, 21st-century skills encompass a wide range of abilities, including critical thinking, creativity, collaboration, and communication, which are crucial for success in the modern world (OECD, 2018). The integration of mobile technology in education and other societal sectors facilitates the development and enhancement of these skills, empowering individuals to thrive in the digital era.

Mobile Technology and the Promotion of Digital Literacy

Mobile technology offers several opportunities for promoting digital literacy and 21st century skills. Firstly, the widespread availability of mobile devices allows for easy access to digital resources, enabling individuals to engage with a variety of learning materials, online courses, and educational apps (Bunhowden & Umar, 2017). Secondly, the interactive and engaging nature of mobile applications facilitates active learning experiences, which enhance critical thinking, problem-solving, and creativity (Wu, Huang, & Sharples, 2020). Moreover, the easy connectivity provided by mobile phones enables collaboration and communication among individuals and groups, fostering collaborative problem-solving and teamwork (Pan, Yu, & Li, 2018). Mobile technology has the potential to enhance digital literacy by providing access to a wealth of information and resources. According to Moatshe, Mpofo, and

Nleya (2018), mobile devices can be used to engage learners in interactive and collaborative learning experiences, allowing them to develop critical thinking, problem-solving, and information literacy skills. In addition, mobile apps and resources can help individuals develop digital literacy skills, such as the ability to evaluate the credibility of online information, communicate effectively in digital environments, and create and share digital content (Ngwenya, 2017).

Importance of Digital Literacy and 21st Century Skills

According to the World Bank (2019), digital literacy and 21st century skills are essential for building a competitive and dynamic economy, as they enable individuals to adapt to changing technologies and contribute to innovation and productivity. By equipping learners with digital literacy and 21st century skills through mobile technology, nations can develop a skilled and adaptable workforce that is capable of driving sustainable economic growth and development. Digital literacy and 21st-century skills play an important role in the following way:

1. **Economic opportunities:** Digital literacy is essential for individuals to take advantage of the numerous economic opportunities offered by the digital economy. As more jobs and industries become digitized, those with digital skills and literacy will have a competitive edge in the job market.
2. **Communication and collaboration:** 21st-century skills enable effective communication and collaboration in a digital environment. These skills are necessary for individuals to participate actively in online discussions, work remotely, and collaborate with colleagues or clients across geographic boundaries.
3. **Information and media literacy:** Digital literacy equips individuals with the ability to critically evaluate information and media they encounter online. With the vast amount of news, articles, and social media content available, having the skills to discern reliable and accurate information is crucial to make informed decisions.
4. **Technological competence:** With technological advancements happening at a rapid pace, digital literacy helps individuals navigate and adapt to new technologies and tools. Being technologically competent allows individuals to effectively use digital devices, software, and applications to solve problems, increase productivity, and enhance creativity.
5. **Lifelong learning:** Digital literacy encourages lifelong learning by providing individuals with the skills to access and utilize online learning resources. With digital literacy, individuals can engage in online courses, webinars, and other digital platforms to acquire new knowledge and skills throughout their lives.
6. **Civic engagement:** Digital literacy empowers individuals to actively participate in civic life. Through digital platforms, individuals can engage in

political discussions, access government services, and express their opinions on social issues. Digital literacy also facilitates online activism and citizen journalism.

7. **Personal growth and well-being:** 21st-century skills enable individuals to manage their digital lives responsibly and safely. Digital literacy helps individuals protect their online privacy, recognize and mitigate cyber threats, and maintain a healthy balance between online and offline activities.

Role of Mobile Technology in Promoting Digital Literacy and 21st Century Skills for Sustainable National Development

1. **Access to Information:** The role of mobile technology in promoting digital literacy and 21st-century skills for sustainable national development is significant (Smith, 2017). Mobile technology, such as smartphones and tablets, allows individuals to access information and educational resources anytime and anywhere (Johnson, 2019). This accessibility enhances digital literacy by providing opportunities for people to learn and develop skills in using technology effectively and efficiently (Gupta, 2018).
2. **Addressing the Digital Divide:** Mobile technology plays a crucial role in sustainable national development by bridging the digital divide. It allows access to educational resources, healthcare information, and e-government services in rural and remote areas (Chen, 2018). This connectivity empowers individuals and communities, enabling them to participate actively in economic and social development.
3. **Acquisition:** Mobile technology enables the acquisition of 21st-century skills, including communication, collaboration, critical thinking, and problem-solving (Howard, 2016). Through various mobile applications and platforms, individuals can connect with others, collaborate on projects, and engage in critical thinking activities (Martinez, 2020). These skills are vital for the advancement of individuals and the overall development of a nation in the digital age.
4. **Social Connectivity:** Mobile technology serves as a catalyst for social connectivity, enabling users to engage in online communities and digital networks. Digital literacy is essential for individuals to navigate and participate effectively in these virtual spaces (Huett, Moller, Foshay, & Coleman, 2008). Through the use of mobile devices, individuals can cultivate online relationships, collaborate on projects, and exchange knowledge, thereby embracing the social aspects of digital literacy.
5. **Creative Content Production:** Mobile technology encourages individuals to become creators of digital content, providing platforms for self-expression and innovation. Digital literacy empowers users to utilize various media creation tools and applications effectively (Hobbs, 2010). By developing

skills in digital literacy, individuals can produce, edit, and share multimedia content seamlessly, thus fostering creativity, communication, and digital citizenship in the mobile era.

6. **Promoting Digital Literacy:** Mobile technology plays a significant role in promoting digital literacy and 21st-century skills for sustainable national development. Its ability to provide access to information, enhance skills development, and bridge the digital divide is instrumental in ensuring that individuals and communities can thrive in the digital age (Smith, 2017).

Impact of Digital Literacy and 21st Century Skills on Sustainable National Development

The deep impact of digital literacy and 21st-century skills on national development cannot be understated. Sustainable national development requires a skilled workforce capable of adapting to the evolving demands of a knowledge-based economy (Trilling & Fadel, 2009). By promoting digital literacy and 21st-century skills through mobile technology, nations can equip their citizens with the necessary competencies to participate actively in the digital workforce, foster innovation and entrepreneurship, and drive economic growth (Garcia- Peñalvo et al., 2019).

Conclusion

In conclusion, mobile technology is a powerful tool for promoting digital literacy and 21st-century skills, leading to sustainable national development. It provides access to educational resources, facilitates personalized learning, enhances communication and collaboration, fosters digital citizenship, and promotes innovation and entrepreneurship. Embracing mobile technology is essential for individuals to thrive in the digital age and contribute to the overall progress of a nation. Through the use of mobile devices, learners can access a wealth of information and resources, engage in interactive and collaborative learning experiences, and develop essential digital and 21st century skills. As nations continue to embrace mobile technology in education and training, they can harness its potential to build a skilled and adaptable workforce, and drive sustainable economic growth and development.

Recommendations

To achieve sustainable national development through the effective integration of mobile technology to promote digital literacy and 21st-century skills, the following steps can be taken:

1. **Infrastructure Development:** Ensure access to reliable, affordable, and high-speed internet connectivity across the nation, especially in rural and underserved areas. This will serve as the foundation for mobile technology integration.

2. **Mobile Device Distribution:** Expand the availability and affordability of mobile devices such as smartphones and tablets, ensuring that a majority of the population has access to these tools. This can be done through government initiatives, subsidies, or partnerships with mobile device manufacturers.
3. **Digital Literacy Programs:** Implement comprehensive digital literacy programs at both national and local levels. These programs should focus on teaching people how to effectively use mobile devices, access information online, critically evaluate digital content, and utilize various digital tools for communication, collaboration, and problem-solving.
4. **Curriculum Integration:** Integrate digital literacy and 21st-century skills into the national curriculum across all levels of education. This should involve updating existing subjects to incorporate aspects of digital literacy and integrating the use of mobile technology into teaching practices. Encourage schools to adopt digital textbooks, online learning platforms, and collaborative digital tools to enhance student engagement and learning outcomes.
5. **Teacher Training:** Provide specialized training programs for teachers to enhance their digital literacy skills and equip them with the knowledge and confidence to integrate mobile technology effectively into their teaching practices. This can include workshops, seminars, and online courses.
6. **Public-private partnerships:** Foster collaborations between government agencies, educational institutions, and private sector entities to promote the development of mobile technology-based solutions for education and skill development. This can include mobile applications, online courses, and digital learning platforms, which can then be integrated into existing educational systems.
7. **Community Engagement:** Conduct awareness campaigns and community engagement programs to promote the benefits of digital literacy and the use of mobile technology for personal and professional growth. Engage community leaders, NGOs, and local organizations to ensure effective dissemination of information and resources.
8. **Continuous Evaluation and Improvement:** Regularly evaluate the impact and effectiveness of mobile technology integration programs. Monitor and measure digital literacy levels, 21st-century skill development, and economic growth indicators to refine strategies and policies.

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Determination of Nitrate, Sulphate and Phosphate in Borehole Drinking Water Irukekpen, Edo State

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Abstract

The study of borehole water was conducted to investigate nitrate (NO_3^-), sulphate (SO_4^{2-}) and phosphate (PO_4^{3-}) concentrations in drinking water and its associated health implication to residents and its environs. Samples were collected from borehole around the vicinity of Irukekpen town using polythene plastic containers and were analyzed for the nitrate, sulphate and phosphate levels following within the permissible limits recommended by the World Health Organization (WHO) standards. From the results, it was found that Nitrate has a mean value of 0.054 mg/l. above permissible values of 250mg/l WHO (2011) guidelines standard. Sulphate has a mean value of 0.850 mg/l over-exceeded permissible values of 250mg/l WHO standard (2011) and Phosphate with a mean value of 0.022 mg/l which fall below than the permissible values of 250mg/l WHO (2011) guidelines standard. Hence, the results indicated that the borehole water is contaminated and unsafe for human consumption. This therefore, calls for appropriate treatment measures before the consumption of these waters by the populace to avoid long term accumulative health problems of these pollutants.

Keywords: Borehole water; nitrate, sulphate, phosphate and health implications

Introduction

Water is the most important natural resources without which life would be nonexistent. Availability of safe and reliable source of water is an essential prerequisite for sustainable development. Deserts are not habitable because of lack of water (Asonye, *et al.*, 2007). Surface waters such as rivers, streams, lakes and dams and ground water such as wells and boreholes are the principal sources of water. Ground water (borehole) quality and availability remain one of the most critical environmental and sustainability issues of the twenty-first century by World Health Organization, (2002). In recent years, because of rapid urbanization, growth population and industrialization, the rate of discharge of pollutants into the environment which find their way into these water bodies is higher than the rate of purification (Reza, and Gurdeep, 2009). It is believed that surface water is generally



more polluted than ground water; hence the use of ground water (borehole) as the major source of drinking water is preferred. Ground water can also be contaminated through various ways such as seepage from effluent waters, vehicle maintenance, sewage and domestic water, mining activities fertilizer from agricultural activities etc. (Adekunle, 2009). Ground water constitutes over 90% of the world's readily available freshwater resources (Reza, and Gurdeep, 2009) with remaining 10% in lakes, streams, dams and rivers. However, groundwater is not only a valuable resource for drinking water supply, but also a vital component of the global water cycle and the environment. As such, groundwater provides water to rivers, lakes, ponds and wetlands helping to maintain water levels and sustain the ecosystems (Kim,*et al.*, 2003). Safe potable water is essential for healthy living and for water to be regarded as safe for drinking; it must meet certain physical, chemical and microbiological criteria set by American Public Health Association, (2012).

Borehole Water (Groundwater)

Borehole water is widely used as a source, for drinking water supply and irrigation in food production (Suthra, *et al.*, 2009). However, groundwater is not only a valuable resource for water supply, but also a vital component of the global water cycle and the environment. The groundwater (borehole) water contamination by chemical species such as heavy metals, sulphate, nitrates, phosphate, fluorides, microorganisms etc. can affect the health status of humans who is the ultimate user of the water. These chemical species find their way into the water aquifer through leaching. Such human activities that introduce these unwanted species to the groundwater are processing of metals, exploration, production and eventual exploitation of oil, agricultural activities, and mining and through indiscriminate disposal of the byproducts of these human activities has added to the already overburdened situation (Adefemi, and Awokunmi, 2009). The manner in which the inhabitant of a particular area disposes wastes can also contribute to the level of contamination of the groundwater. The groundwater can be easily polluted through wastes, sewage and effluents that originate from homes, industries and commercial centers through percolation into the water underground.

Water is a necessity, to maintain good health; water must be kept safe and free of contamination/pollution of any type. Good drinking water supply to Nigerian's teeming populace is a perennial problem that has defied solution. As such, great concern must be given to the quality of drinking water as it is very critical for the overall socio-economic development of any society and, should engage the attention of individuals, groups, government and non-governmental organizations (Adetunde, and Glover, 2010).



The study therefore, stresses on the need that public should be provided with an alternative water source for drinking and domestic purposes. The acute water shortage forced many people to drink untreated water obtained from surface and underground sources thereby exposing them to hazardous chemicals and infectious agents. This has made many researchers to focus their attention towards evaluation of physicochemical and microbial characteristics of water supplies (Okonkwo, and Okorie, 2011). Contamination of water bodies has increasingly become an issue of serious environmental concern. Clean water is a priceless and limited resource that man has begun to treasure only recently after decades of pollution and waste (Silberberg, 2003). Potable water is an essential ingredient for good health and the socio-economic development of man but it is lacking in many societies (Udom, *et al.*, 2002). All Natural waters contain many dissolved substances. Contaminants such as bacteria, viruses, heavy metals, nitrates and salt have polluted water supplies as a result of inadequate treatment and disposal of waste from humans and livestock, industrial discharges and over-use of limited water resources (Singh and Mosley, 2003). To avoid groundwater pollution from effluent leachate, the community water and sanitation Agency (CWSA) recommends that pit latrines should be constructed at least 100 feet (30m) downhill of boreholes (CWSA, 2003). In addition, World Health Organization, (2006a) asserted that a minimum of 50 feet (15m) between a pollution source and downstream water abstraction point will be satisfactory. Water has different types of physical, chemical and biological impurities. These require different tests to determine the level of these contaminants in the water. To obtain water of good quality, it should be tested for trace metals, heavy metals, organic materials and biological contaminants. For water to be considered as good for drinking then it should pass all these tests and it should also contain required amount of mineral level (Umar, 2006). Previous studies on boreholes water from Kano, (Sa'eed and Mahmoud, 2014) had reported that, most of the physicochemical parameters analyzed were within the maximum permissible limit set by World Health Organization, (2020). This work was set to explore a wider scope of various local Governments within the Kano metropolis. Nitrate-containing compounds in the soil are generally soluble that means they dissolve easily in water Agency for Toxic Substances and Disease Registry, (2011). Thus, nitrates flow easily into groundwater. Microbes break down animal and human organic wastes in soil and water to ammonia. This breakdown process of converting organic wastes into ammonia, which oxidizes into nitrite and nitrate, is referred to as Nitrification process (Oladeji, 2017). Plants uptake phosphate from soil mostly in the orthophosphate forms. Natural soil phosphate level is often low enough to limit crop production. Both inorganic phosphate fertilizers (treated rock phosphate) and organic phosphate sources (animal manures) are equally adept at supplying the

orthophosphate ion and correcting phosphate deficiencies in soil (Edwards,*et al.*, 1990). The primary biological importance of phosphates is components of nucleotides which serve as energy storage within cells Adenosine Triphosphate (ATP). Phosphorus is also found in bones and the enamel of mammalian teeth whose strength is derived from calcium phosphate. It is also found in the exoskeleton of insects and phospholipids (Huttner,*et al.*, 2006). In addition, it functions as a buffering agent in maintaining acid base homeostasis in the human body. Sulphate is produced in the environment from the oxidation of elemental sulphur, sulphide minerals or organic sulphur. It is naturally occurring compound containing sulphur and oxygen present in various mineral salts that are found in soil forming salts with variety of elements like barium, calcium, magnesium, potassium and sodium (Kamar, *et al.*, 2011). Sulphate may be leached from the soil into groundwater and commonly found in most water supplies.

Borehole Water Quality

The quality of groundwater is of vital concern for mankind since it is directly linked with human welfare. According to Ranjana (2010), the quality of public health depends to a greater extent the quality of groundwater. Though groundwater quality is believed to be quiet good compared to surface water, its quality is the sum of natural: geology of the environment and anthropogenic influences: withdrawal, land use change, and solid waste dumping (Chapman, 1996). Water quality parameters reflect the level of contamination in water resources and show whether water is suitable for human consumption. Contaminated water is unacceptable due to health effects, poor taste and aesthetic value to consumers (Suthra, *et al.*, 2009).

Statement of the Problem

The important of human health cannot be overemphasized, therefore, this research has highlighted some of the problems involved when consuming unsafe borehole water which contains nitrate, sulphate and phosphate undermine the dangerous health risk implications and the enormous risk associated with those compounds that are deadly. Such diseases are; Blue-babysyndrome, gastrointestinal cancer, vascular dementia, adsorptive secretive functional disorders of the intestinal mucosa.

Aims and Objectives

The aim of this study is to determine some anions in boreholes drinking water and the health risk implications. While the objectives is to determine concentrations of nitrate (NO_3^-), sulphate (SO_4^{2-}) and phosphate (PO_4^{3-}) in borehole drinking water

Location of the Study Area

The study area is situated within latitude $6^{\circ} 30^1$ N and longitude $6^{\circ} 35^1$ E as shown in Figure 1. It lies between the fringes of the Savannah to the North and the forest to the South. It is made up of Sandy topsoil that could easily be cleared and cultivated,

relatively weed-free. It has a flat landscape devoid of rocks and mountains, and good for agricultural purposes. This has been responsible for good crop yield in the region, especially yams. The position of the study area is a favorable climatic zone that enhanced agricultural development and the entire economic structure of the area.

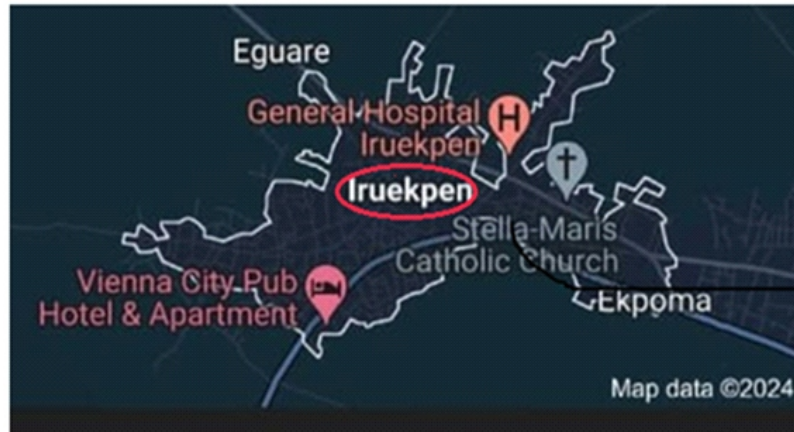


Figure 1: Map of Iruẹkpen in Edo State as the study area location

Borehole Water Contamination

Contamination of water has increasingly become an issue of serious environmental concern (Akpoveta, *et al.*, 2011). The habit of indiscriminate waste disposal, poor agricultural practices, septic tanks, pit latrines and graves near boreholes and poor well construction contribute to borehole water contamination (Singh and Mosley, 2003; Lu, 2004). These account for the presence of coliform bacteria in borehole water and lead to possible diseases if consumed without any form of treatment. According to World Health Organization, (2018), contaminated water can transmit diseases such as diarrhea, cholera, dysentery, typhoid and polio. Among these water-related diseases, diarrhea has a higher death possibility percentage. This shows that it is important to certify the quality of water used for domestic purposes to prevent these deadly diseases.

Nitrates in Borehole Water

Nitrate is a family of chemical compounds containing atoms of nitrogen and oxygen occurring naturally. Nitrate is critical to the continuation of life on the earth, since it is one of the main sources from which plants obtain the element nitrogen. The element is required for the production of amino acids which in turn are used in the manufacture of proteins in both plants and animals (Edori, *et al.*, 2016). Nitrate contamination of groundwater results from leaching of fertilizer, septic tank leachate, answered sanitation, pit latrines, animal waste or human waste

mineralization of decomposing or oxidation of decaying matter by soil micro-organisms (Suthra, *et al.*, 2009). Nitrate can readily be transported beneath the soil zone because it is relatively soluble and not prone to ion exchange (Stumm and Morgan, 1996). Nitrate can be endogenously reduced to nitrite, which can then undergo nitrosation reaction in the stomach with amines to form a variety of N-nitroso compounds (NOC). These compounds are carcinogens, thereby causing health hazards like impairing the ability of the blood to carry oxygen (Blue-baby syndrome or infantile methemoglobinemia), gastrointestinal cancer, vascular dementia, adsorptive secretive functional disorders of the intestinal mucosa. Nitrate contamination can be treated by technologies such as ion exchange; denitrification and reverse osmosis or anaerobic reduction in the subsurface which can limit nitrate contamination of groundwater (Kapoor and Viraraghavan, 1997). Nitrate is not especially dangerous but certain bacteria sometime present in digestive tract convert nitrates into nitrites, which are highly toxic. Nitrates are widely present in substantial quantities in soils and in most water. Nitrates are products of oxidation of organic nitrogen by bacteria present in the soils and in the water where sufficient oxygen is present.

Sulphate in Borehole Water

Most of the metallic sulphates are soluble in water which implies possible leaching of sulphate from the top soil to the surface water, and underground water. Sulphate concentrations in the groundwater have about 69% violations with respect to the World Health Organization stipulated limits (250 mg/L) for sulphate ions in drinking water. The excessive levels of sulphate in water can lead to laxative effects in humans, while moderate levels could induce salty taste in drinking water depending on the associated anions. Oxidation of sulphide from sulphurous gases discharged to the atmosphere which often result in acid rain water containing detectable levels of sulphate at industrial areas may also lead to the high sulphate content. This means that there is a significant difference in sulphate values among the boreholes water samples. The results also showed that agriculture wastes especially runoff from fertilizer application contributed to concentrations of nitrate and phosphate in the groundwater sample. The foregoing may be responsible for the salty taste of water from deep aquifers within the study area (Emenike, *et al.*, 2018b). The elevated sulphate concentration is also associated with the excessive use of agro-chemical and dissolution of basement rocks.

Phosphate in Borehole Water

Phosphorus is essential to the growth of biological organism including both their metabolic and photosynthetic process. Phosphorus occurs naturally in bodies of water mainly in the form of phosphate (i.e a compound of phosphorus and oxygen).



Phosphorus, as phosphate is usually not a concern in ground water, since it is tenaciously held by soils through both electrostatic and non-electrostatic mechanism and usually does not leach in most soils. However, in sandy soils that contain little clay, phosphate can leach through the soil and impact borehole water supply perhaps, the greatest concern with phosphorus is contamination of streams and lakes via surface run off and erosion by Organization of Assabet River (2002).

Phosphates constitute a very important pollution problem whenever it is found in significant amount. It promotes algal growth and/ or microphytes, leading to the cyclic problem of eutrophication (Thriodore, 2004). The high level of phosphate ion in the drinking water is attributed to the proximity of the settlements to those places where farming activities is taking place all year around.

Health Implications

Nitrate in borehole water involves various risks for human consumption. Mortalities as a result of methaemoglobinaemia are a reality. New information became available on earlier cases of methaemoglobinaemia, while spontaneous abortion may constitute a further risk related to nitrate in water. Microbiological pollution seems to aggravate the situation, increasing the risk of methaemoglobinaemia at lower nitrate concentrations and should be avoided. The risks associated with nitrate ingestion have to be evaluated in terms of the total dietary intake of nitrate and nitrite. The intake of nitrate, and particularly nitrite from cured meat, has to be taken into account in this calculation. At higher nitrate concentrations livestock is also at risk and nitrate poisoning of livestock has been recorded in southern Africa and elsewhere (Edori, and Kpee,2016).

Materials and Methods

The borehole water sample was collected from the study area with a view to determine Nitrate (NO_3^-), Sulphate (SO_4^{2-}) and Phosphate (PO_4^{3-}). In the preparation of reagents, chemicals of analytical grade purity (chromic acid) were used, and all glass water bottles (250ml) involved were sterilized with deionized water, rinsed and dried at room temperature. The borehole water was then pumped to fill the Polyethylene plastic bottles, each of the three bottles were labels for identification of the water sampled collected from the borehole. The bottles were sending to the laboratory in an insulated box to prevent external factors like high temperatures from changing some of the water parameters. Analysis was commenced within 12hrs and sampling Standard methods were followed as listed by American Public Health Association, (2012).

Determination of Nitrate (NO_3^-), Sulphate (SO_4^{2-}) and Phosphate (PO_4^{3-})

25cm³ of water samples was pipetted into the sample cell, 20cm³ of sodium nitrate (NaNO_3) reagent powder was measured with measuring cylinder, 250ml of distilled water was added and pour in volumetric flask, this was mix vigorously for 2-minute to dissolve the powder. The sample concentration was recorded at 500nm.

In determine sulphate (SO_4^{2-}), 25 cm³ of water samples was pipetted into the sample cell, 15g of sodium sulphate (NaSO_4) powder was measured with measuring cylinder and 100ml of distilled water was measured and pour in volumetric flask, this was swirled to mix and dissolve the powder. The cell was allowed to stand undisturbed for 5-minutes. The sample concentration was recorded at 450nm.

Finally, in phosphate (PO_4^{3-}), 25cm³ of water sample was pipetted into the cell, 2.5g of sodium molybdovanadate reagent powder was measured with measuring cylinder and 25cm³ of distilled water was added and this was swirled to mix and dissolve the powder. The mixture was allowed to stay for 3-minutes and the sample concentration was recorded at 430nm. Hence, the nitrate, sulphate and phosphate used portable data logging spectrophotometer (721 models), and the values obtained were all recorded. The entire blank samples were treated in the same manner American Public Health Association, 2012).

Results and Discussion

Results on borehole water analysis were carried out in order to determine the Nitrate (NO_3^-), Sulphate (SO_4^{2-}) and Phosphate (PO_4^{3-}).

Table 1: Shown results on borehole water analysis

Parameters	Frequency (nm)	Results	WHO, 2011
Nitrate (NO_3^-)	500	0.054	250ml/g
Sulphate (SO_4^{2-})	450	0.850	250ml/g
Phosphate (PO_4^{3-})	430	0.022	250ml/g

The results of borehole water conducted to determine nitrate (NO_3^-), sulphate (SO_4^{2-}) and phosphate (PO_4^{3-}) concentrations was shown in Table 1. The determination was done to ascertain the quality of drinking borehole water as regard to health implications. The nitrate analysis was done with a mean value of 0.054 mg/l. Though, the value is high but not exceeds the values set by World Health Organization, (2011). The result indicated that water source containing high levels of nitrate (100 mg/l) is contaminated and should not be used for preparation of infant foods. Therefore, this calls for appropriate treatment measures before the consumption of this populace to avoid long term accumulative health problem.



The sulphate analysis was done with a mean value of 0.850mg/l. The sulphate values obtained exceeded the permissible range (250 mg/l) based on World Health Organization, standard (2011). The result shows that water above the permissible value (250mg/l) is unfit for consumption and may induce respiratory ailments in humans due to offensive odor and taste causing those exposed to water with higher concentrations of sulphate. Sulphate levels in water are expected to be around 250 mg/l. Therefore this, calls for adequate treatment and well-disposal of waste from humans and livestock, industrial discharges and over-use of limited water resources. The phosphate analysis was equally done with a mean value of 0.022 mg/l. The value obtained was below World Health Organization, (2011) permissible guideline value of (250 mg/l). The result indicated that the concentrations of phosphate ions might increase during the wet season when agricultural activities are at their peaks, thus, it caused health hazards such as blue baby syndrome in the case of excess phosphate. However, it was established that, high phosphorous concentration played better role in causing eutrophication of water bodies (World Health Organization, 2004).

Conclusion

In conclusion, the borehole drinking water from the study areas were analyzed and found to be below/above 250mg/l World Health Organization, standard for drinking water. Based on the results, the values obtained in nitrate, sulphate and phosphate indicated that the borehole drinking water is generally originated from anthropogenic activities and natural accumulation of nitrate in the groundwater. Thus, this indicated that the borehole water are unsafe for drinking purpose, and if it must be consumed it must be regularly treated to avoid health implications. Hence, information on drinking water quality should be considered as a reflection of quality of life. However, people may be aware of the dangers associated with the consumption of unsuitable borehole drinking water.

Recommendation

It is recommended that water from the borehole in the study area should not be used as drinking water to avoid dangerous health implications, except it is treated to meet the World Health Organization parameter standards for portable water before it released for public consumption.

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Ergonomic Centred Pedagogy for Improving the Teaching of Programming Languages in Tertiary Education

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Abstract

The paper reveals the content of this research aimed at showing ergonomical possibilities that enhance success in teaching and learning of programming language, by tertiary education students. successful considerations for pedagogical approaches were considered, with providing measures that improve the difficult task of teaching programming language. The strategies inherent will provide guidance for the implementation of the various pedagogical technologies that will intensify students' interest in learning of programming languages at undergraduate level. The Ergonomic consciousness will help those who find it difficult to grasp programming concepts quickly enough to achieve good grades. There is also a myriad of options and approaches to choose from. This paper outlines some of the options and approaches and summarizes that choosing a simple, well-structured environment and technology that encourages collaboration whilst giving lots of feedback to students is major effective strategy when teaching programming languages to students.

Keywords: Ergonomic strategies, pedagogical tools, programming Language

Introduction

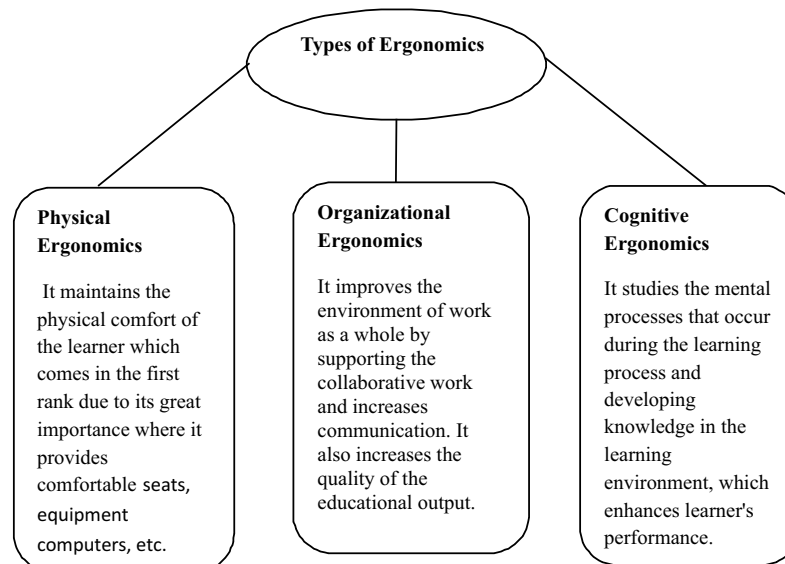
Utilizing innovative approaches to design and manage inductive learning environments that effectively satisfy the needs of 21st-century learners is an increasingly important theme of educational research. The methodological shift from instructivism to constructivism alters the work of teachers from information transmission to the design and management of student-centered learning tasks and learning environments within which learners can learn safely through exploration and interference with the objects in the environment as well as having to take a significant level of responsibility for regulating their learning behaviours and products. Ergonomics is one of these innovative approaches that focus on the optimum design and usability of physical things within the learning environment. The focus of contemporary pedagogy is on pedagogical ergonomics, which tries to thoroughly examine and design educational activities within all aspects of the educational system, including those of the instructor, the student, and the learning environment, to guarantee their efficacy and optimality. Wilson (2000) defines ergonomics as the scientific study of the interactions between human factors and other elements of a system, to enhance human welfare and the productivity of a system as a whole. Raby et al. (2003) assert that ergonomics stems from the Greek

'ergon' meaning work, and 'nomos' meaning rules. This discipline studies human/machine interactions in different environments including the educational world. Faheem (2021) adds that ergonomics refers to the science of improving product design to optimize human convenience and comfort. It is the study of how to arrange equipment and furniture so that people can work or perform other activities more efficiently and comfortably considering the relationship between workers and their environment. The International Ergonomics Association (IEA, 2003; cited in Karwowski, & Zhang, 2021, p. 3) defines ergonomics as follows:

The scientific discipline which is concerned with understanding the interactions among humans and other elements of a system and the profession that applies theory, principles, data, and methods to design to optimize human well-being and overall system performance.

Guerrettaz (2021) mentions that ergonomics is an interdisciplinary field that seeks to understand purposeful human activity, including fields such as industry and office workplaces, medicine, energy systems, aviation, and sports. Ergonomics is centrally concerned with patterns of human-object relationships that are best understood overall in relation to sociocultural contexts. Karwowski and Zhang (2021) state that the ergonomics discipline emphasizes a human-centered, holistic approach to system design that considers the organizational, developmental, ecological, and environmental aspects of human well-being as well as the physical, cognitive, and neurological aspects. In this perspective, Christy and Duraisamy (2020) refer to three main types of ergonomics: physical, cognitive, and organizational (figure 1)

Figure 1: Types of Ergonomics



1. **Physical ergonomics (PS):** It is the most important type, where physical comfort comes first in terms of importance to the students. The tools used include comfortable seats, computer equipment, etc.)
2. **Organizational ergonomics (OE):** It examines ways to improve the entire work environment. It includes finding ways to enhance teamwork, advanced communications, and increase the quality of work production.
3. **Cognitive ergonomics (CE):** It focuses on cognitive procedures in the design of environment and technology. It is a scientific discipline that studies, evaluates, and designs outputs, tasks and environments, and systems and how individuals interact with their cognitive abilities. It is mental processes that include cognition, memory, rational thinking, motor response, and interrelationships among students in a learning environment. It includes related tasks, decision-making, and performance-based skills, interaction between humans and the work system, reliability on humans, and stress at work and training.

Ergonomics, Žunjiæ *et al* (2015) mention, highly contribute to the quality of education through three streams including preserving students' health, creating a comfortable working environment, and adjusting instruction according to students' abilities. Dul and Ceylan (2011) clarify that the field of ergonomics deals primarily with the working environment, improving health and safety, and sometimes productivity and quality. Designing a work environment that enhances creativity and the ability to innovate in products and processes. The degree to which individuals generate new and useful ideas depends on the support they receive from their work environment. The goal of ergonomics is to optimize human well-being and overall system performance." A creative learning environment can promote students' and teachers' well-being.

Therefore, there should be facilities that provide interventions that make the work environment more conducive to members' creativity.

What is obvious in the introduction is that ergonomics is an instructional approach in computer science education. This research attempts to make contributions at both theoretical and practice levels as pedagogical ergonomics is illustrated in relation to multiple specializations of human knowledge and insights for utilizing ergonomics in programming language considerations due to the fact that programming is rarely by students. Thus, this research calls for more use and development opportunities of ergonomics to provide an enhanced learning environment with rich tasks for learners

of programming language. Additionally, this research aims to raise awareness of the importance of ergonomics in the field of Computer science education particularly in the branch of artificial intelligence (AI) and encourages AI teachers to implement it. The focus of this research lies in exploring how PE, CE, and OE can be implored in teaching basic programming language to tertiary education students. Moreover, the three types of ergonomics are integrated and lead to more productivity in using programming language skills. Accordingly, this research explores one main question: How could ergonomics be incorporated into teaching Programming Language? This question and more basic ones, are such that inform this research:

1. What is pedagogical ergonomics?
2. What need do computer science and programming language students have towards to learning?
3. How can Ergonomics be incorporated into teaching programming language?

Therefore, the current research sheds the light on the significant role of using ergonomics in teaching basic programming language integrated skills. Following is a review of what pedagogical ergonomics refers to, rationales for incorporating it into computer education, and the implications for utilizing ergonomics in developing programming Language skills are provided.

Pedagogical ergonomics

Although the application of ergonomics in education has gotten relatively little attention, it is one area where it can have a substantial impact. Educational ergonomics, as Kao (1976) conceptualizes it, is an interdisciplinary branch of ergonomics that targets educational effectiveness focusing on the interaction of educational performance and educational design. Tang (2020) adds that educational ergonomics is part of a learning environment that depends on the interaction of learning performance and learning design. Educational ergonomics is an alternative to traditional educational studies as it provides a comprehensive approach to design factors at different levels such as classroom, policy, and program levels that help to enhance the effectiveness of education in various local and regional institutions. Pedagogical ergonomics, as Kuts and Lavrentieva (2022) note, is a new direction of modern pedagogy that aims to comprehensively analyze and design the pedagogical activities of teachers and students in the system and consider the relationship of the human factor with the elements of the learning environment to assure its effectiveness and optimality. Furthermore, pedagogical ergonomics focuses on designing appropriate alternatives for particular activities related to using new technology; formulating requirements for technical teaching aids and considering

the level of readiness of teachers and students to use instrumental pedagogical technologies. Many educators and researchers linked educational ergonomics to constructivism. Soltaninejad et al. (2021) argue that ergonomics is highly connected to the constructivism theory where learning occurs through the interaction of the student with the other students, the teacher, the educational materials, and the learning environment in order to construct new knowledge or solve a problem. Bures (2014) points out that the learning environment in which the student spends long hours must be a safe, attractive, healthy, and enriched place to pave the way for better learning. In the constructivist approach, Anagün (2018) adds, learning occurs when students explore and interpret their surroundings and one of the teachers' main challenges is to create an effective learning environment that encourages students to participate actively in learning activities. Aljohani (2017) mentions that constructivism entails some important principles which help teachers design supportive learning environments that consider learners' different backgrounds, knowledge, experiences, and interests to help learners make connections, construct knowledge and solve problems. The social constructivist theory entails one of the important principles which is the meaningful participation in the social life of a group and the meaningful use of language as an interpersonal, intersubjective, and collaborative process of creating shared meaning. Ergonomics is one of the instructional approaches that can help in solving many problems students face and can increase their productivity. In educational systems, Smith (2007) argues, student learning success is significantly correlated with some design factors including task design, design of the teaching process, design of educational materials, environmental design of the classroom, design of educational technology, educational system design, and community quality. Kao (1976) categorizes Educational Ergonomics into five categories as follows:

1. **Learning ergonomics** examines educational skills of handwriting, reading, drawing, using tools, managing educational activities, and the assessment system.
2. **Instructional ergonomics** includes designing books, teaching aids, teaching methods, and lesson preparation.
3. **Ergonomics of educational facilities** involves educational furniture, laboratories, library, classroom, and office design.
4. **Ergonomics of educational equipment** provides educational equipment with quality assurance of performance, fixtures, and safety.
5. **Ergonomics of educational environment** which is concerned with lighting, space, colors, and placement of devices.



Uche and Okata (2015) and García-Tudela et al. (2020) agree that ergonomics is the approach that provides the adaptation of the physical or the virtual environment to the individual characteristics of its users. Ergonomics does not provide only flexibility and personalization of learning or working environment but also students' well-being and security. If the physical teaching and learning environment lacks the main determinants that help in achieving the success of the teaching and learning process, the desired educational goals will not be achieved. So, there are several considerations to have an appropriate learning environment that must be focused on educational and teaching facilities, the availability of comfortable facilities and buildings, the regularity of their maintenance services, and the suitability of equipment for users. Additionally, Pitehnoee et al. (2020) clarify the importance of physical ergonomics highlighting how the behaviors or development of learners are influenced by the features of the learning environment including ambient aspects (e.g. temperature, air quality, and lighting), physical aspects (e.g. visibility, furniture, and layout), and technical aspects (e.g. personal computers, internet access, audio, and video equipment).

Ansari et al. (2018) state that effective learning and teaching can be achieved in a safe, stress-free space in classrooms. The physical environment of educational facilities can help teaching, learning, and academic performance, while inadequate facilities can cause stress and agitated behaviors in students. Physical environments of classrooms have a vital role in student's satisfaction, and a higher level of satisfaction can increase the level of skills, mentality, and knowledge of students. Educational furniture is used in classrooms of many colleges, institutes, and universities, and students spend a major part of their time sitting on this furniture in classrooms. Many health problems can happen because of improper chair designs and that affects student's academic performance.

Kurata et al. (2015) indicate that the application of cognitive ergonomics contains enhancement in human information processing to reduce accidents and errors and thus develop quality and output. According to Caas (2008), cognitive ergonomists perform a cognitive analysis of interaction to speed up the completion of interaction tasks, cut down on human errors, accelerate learning, and raise user satisfaction with a system. Cognitive ergonomists examine how human work is represented and how it is processed cognitively. The phrases cognition and ergonomics are used to investigate the cognitive aspects of the interaction between people, the work system, and the artifacts that are found in it to effectively design them. When explaining the



interactions with objects, cognitive processes like perception, learning, and problem-solving must be taken into account.

According to Tolan (2016), cognitive ergonomics provides a chance to rethink how we approach education. Cognitive Ergonomics evaluates the nature of the content and introduces it to the brain so that it is prepared to receive it, as opposed to starting by choosing the content and scheduling it for delivery. Much like different portions of the body, different areas of the brain perform some activities better than others. Learning is a process that results from exposure. The brain is constantly aware of its environment, albeit to varying degrees of consciousness. By preparing alternative forms of representation, lowering content complexity, and measuring a material's cognitive complexity, it is crucial to give pupils the freedom to choose their formation.

Due to the importance of using ergonomics in different fields of life, some studies have been conducted to explore its efficiency in the field of education. Tang (2020) investigated the effectiveness of using ergonomics to raise the professional development of 36 master students who worked as translation trainees before graduating from two main universities in China. Results proved the importance of using educational ergonomics in professional development programs for teaching translation in the Chinese language. Additionally, Ehrensberger-Dow et al. (2016) surveyed the aspects of ergonomics as defined by the Association of International Ergonomics and how the three types of ergonomics in professional workplaces relate to translation practices and processes. It was found that CE is concerned with the planning, structuring, and management of user interactions that take place in tandem with organic cognitive functions which resulted in improved performance. Researchers affirm that using language technology tools and resources has become a significant component of professional translation efforts.

Andrade and Cumbajin (2013) conducted a macro project called "Implementing an Interactive English Lab" conducted by 7th Cycle English Career Students at Cotopaxi University of Technology to help students develop and improve their English skills by incorporating new study habits. The main function of the English Lab is to facilitate student interaction and improve communication between teachers and students through the appropriate use of physical and sensory elements such as lighting, colors, sounds, space, and furniture. Ergonomics and furnishings ensure the safety and comfort students need to succeed in their studies. English Interactive Labs



has been developed with quality standards to maintain the physical and mental health of students and teachers while continuing the teaching and learning process with minimal stress and maximum effectiveness. Results revealed that ergonomics promoted the mental, physical and social well being of students and teachers and considered the emotional state in transmitting and receiving knowledge.

Computer Science and Programming Language Needs

According to (O. Adelokun-Adeyemo & S. O. Akinola, 2015) computer Science (CS) is a broad and diverse field encompassing the fields of mathematics, physics, psychology, art and sociology. Indeed, one can look at computer science as a hybrid field of study. More formally, we can say that computer science falls in the field of applied sciences as opposed to the basic sciences. As diverse as the field of computer science is, one activity that remains dominant through the diverse components is programming (Felleisen 2008). This dominance is also reflected in computer science curriculum (Blake 2011) across the world. In tertiary curriculum for computer science education in Nigeria, it is observed that about 30% of the curriculum is focused on programming to a large extent. Over the course of an undergraduate programme in computer science, students are exposed to at least four programming languages in core programming courses and are required to apply programming in a few other courses. With so much hinging on the learning and application of programming, the effective teaching of programming languages is no doubt very important. Despite the huge curriculum share given to programming languages, and their importance to the field, research shows that there is still comparatively high rates of failure when it comes to programming language subjects (Vihavainen et al. 2014) (Kaplan 2009). Students find it difficult to grasp programming at the introductory stage and this has discouraged many from continuing in the field (Gudmundsen & Olivieri 2012). (Kak 2013) concedes that teaching programming is a difficult task. This is more so because teaching programming at the level required by industry can only be undertaken by someone who is very much into the act of programming. Most university lecturers are however more immersed in research within their chosen specialities than in writing the next piece of software. He asserts that teaching programming at the university level, must teach how to interact with the machine, demonstrating how to handle program misbehaviour, teaching how to manage memory efficiently, and well as synchronization and process control. In his



opinion, real programming for a computer scientist, must go beyond just constructs but to the level of understanding the implications of the constructs at the system level and be able to make appropriate decisions for program correctness and efficiency. This divergence of interests is one of the causes of low achievement in programming language courses.

Learning to program is a very important skill for a computer scientist (Blake 2011). (Kaplan 2009) compares the inability of a computer scientist to program to the inability of a mathematician to understand algebra. A situation he terms 'very limiting'. Although (Blake 2011) states quite emphatically that computer science is not programming, and computer scientists are not programmers; he still agrees to the fact that learning to program is very important. So how can programming languages be taught effectively?

Pedagogical Ergonomic measures for effectiveness in teaching Programming Language

Selection of Appropriate Programming Language

Several authors have discussed the issue of the appropriate language for teaching first programming language courses. The debate usually centres on finding a language with minimum memory load i.e. a language in which the concepts to be mastered in order to write the simplest working program in that language is minimal as well as a minimal number of lines of code. A first programming language should be a well-structured language with high computing power, it should be easy to learn and be widely applicable (Howell 2003). (Blake 2011) states that the choice of language to teach is a personal one, because teachers make choices based on their own identities as computer scientists and their definition of the discipline. He however also mentioned that though there might be multiple factors affecting the choice of language to be taught, the learner must not be left out of the equation. That is the characteristics and needs of the learners must also be put into consideration. (Pears et al. 2010) also mention considering the whole curriculum when making the choice.

Some authors argue that the first programming language should be an object-oriented language such as Java or C++. So passionate are some of the proponents of this view that one such person is quoted to have said that it is impossible to teach any other language to a person who has learnt BASIC as a first language (Kaplan 2009).

(Warren 2001) however tries to make a point about teaching introductory programming with scripting languages. His argument is that they were built to create small pieces of code and by being more flexible than C++ and Java-type languages (system programming languages), allows the learners to focus on 'algorithmic issues'. In his paper he classifies four problems with these system programming languages that create huge barriers for programming novices: gratuitous complexity, inconsistency, modes and implementation issues. (Blake 2011) also seems to agree as he states that scripting languages have fewer 'non-obvious' (gratuitous complexity) topics that need to be learnt. He reports how using Scala helped his students to learn programming and transit seamlessly to learning Java in their second year

(Shivers 2008) in her paper alludes to the fact that programming is an important skill in the computer science domain. However, she maintains firmly that the teaching of programming should be focused on the essential ideas that underpin programming and not fads demanded by industry. She emphasised that the teaching of programming should be such that the students develop the capacity to pick up new languages and paradigms by themselves because fads by their very nature, change. The teaching of programming therefore must be focused on the core components and developing problem solving skills. (Felleisen 2008) corroborates this stance in his paper by stating that '*the quick pace of changes in the real world demand that we graduate students who understand the principles of programming languages (POPLs); who can use them to navigate the diverse and formidable maze of programming languages; and students who are prepared to design their own special-purpose languages when needed*'.

Overall, it appears that the most effective language to teaching programming is a language that

1. does not have high notational overhead
2. has simple and rich syntax
3. is well supported with tools such as Integrated Development Environments (IDEs), books, tutorial and web documentation

These criteria are very important especially for introductory course which serves to build a foundation in algorithmic thinking and problem solving. Later in the curriculum, issues such as industrial relevance can be put into consideration to create a viable mix of programming languages learnt by the students to ensure well-grounded skills and marketability. Such a mix might be Python followed by VB, C++ and Java. This will prepare a student to qualify for 66% of programming jobs (DeRaadt et al. 2002).

Selection of Appropriate Teaching Methodology

Programming Tools/Environment

Programming can be done in a visual or command line environment. (Dillon et al. 2012) conducted an experiment in which they compared the ability of novices to switch successfully between the two kinds of programming environments. Their result showed that students who had been first introduced to a command line environment found it easier to transit to a visual environment. Their conclusion is that learning to program using a visual environment is 'easier' to learn because the environment is more familiar to the user. This is because visual environments for programming often use the same WIMP (window, icon, menu and pointing device) features that the user will most probably be used to with other visual applications like word editors and browsers. The consistency and affordance of the environment make it easier for the user to navigate and understand the features. However, they also posit that using the visual environment presents the novice programmer with a higher level of abstraction when programming. For example, by simply clicking a button on the visual environment, the user can compile/interpret and execute the program unlike in the command line environment where the user has to issue specific commands for each activity. These manual interactions, according to (Dillon et al. 2012), create a different mental model that helps the user to better understand what programming is all about. The manual interactions with the compiler are seen to be beneficial in having the 'correct' view of programming as different from using application programs.

(Masterson & Meyer 2001) present a visual programming language SIVIL (Simple Visual Language) that depicts program syntax completely visually. Relying on the claim that visual aids are generally thought to be more effective and more presenting ideas to learners, SIVIL presents program constructs, elements and data flow using pictures, symbols and icons. Like the other visual programming environments, it naturally creates a level of abstraction. This can be seen as an advantage as it lowers the learning curve and may help more students have success with learning programming. (Gudmundsen & Olivieri 2012) demonstrate a similar tool called Visual Logic ©. The tool allows users to create programs via interactive graphical flowchart symbols which are executable. The graphical flowchart symbols help the users to better understand abstract programming concepts such as branching, looping and so on. By almost eliminating the need to learn syntax at an introductory stage, the authors claim that Visual Logic © helps students move on more easily to industrial grade languages.



Combining Classroom Based Lectures Plus Separate Practical Lab Sessions

Another setup is to combine classroom-based lectures with separate practical lab sessions. This is becoming the norm when teaching programming. The arrangement is made such that, the programming concepts are introduced during the lectures and then exercises relating to those concepts are worked out during the lab sessions. Usually, the lab session is taken by a different person such as a graduate assistant in the university setting or a technologist. This arrangement is certainly an improvement over the purely classroom-based style but can be riddled with problems if not properly managed by the course lecturer. This system has helped many students to grasp programming concepts and languages more easily which resulted in better grades for the students.

Practical lab sessions

Full-fledged practical sessions are becoming pervasive. They are the dominant style being used in IT certification-focused institutions such as NIIT and Aptech in Nigeria. In this setting, usually, all teaching takes place in a computer lab with each student having access to a personal computer. The lecturer demonstrates via a projector and the students replicate what is being done instantly. This approach creates a rapport between the student and the teacher and can help them learn faster since problems can be dealt with immediately. This arrangement is however resource intensive and time consuming.

Other Teaching Interventions

More and more programming courses seem to be thought using extreme programming. As agile development has continued to gain ground, it has filtered its way into education as well. A number of researchers have reported positive experiences with extreme programming as well as pair programming. (Karn & Court 2003) describe a 'software hut' at the University of Sheffield, United Kingdom, where students work in teams on real life projects. Though their research was focused on how personality affects team success, the scenario in which the research was carried out goes to show that schools are adopting industry-like teaching and learning environments.

Several researchers have reported improvement in performance of students when pair programming was used. Pair programming has also been reported to enhance achievement of students (Akinola, 2014; Brain Hanks, 2008). (Shaffer & Edwards 2007) in their research however, they did not notice any impact of pair programming on the performance of their subjects.

(Vihavainen et al. 2014) carried out a systematic literature review of interventions to improve students' achievement in programming language courses. In their research, they discovered thirteen interventions which had been used in different scenarios. The result of their study revealed that Media Computing topped the list of interventions that helped students grasp the concept of programming and hence achieve success. Media Computing with pair programming came second, Cooperative third, using a visual programming tool fourth, extreme apprenticeship and team-based learning came fifth and sixth. Having a preliminary introductory course also produced good results coming seventh. Reducing class size, improving resources, using games, pair programming, modifying assessment and collaboration with games ranked eighth to thirteenth in order. Their study focused on introductory programming and there is evidence that as students mature, some interventions such as pair programming, become more effective.

Conclusion and Recommendation

Ergonomic factors which may contribute to the effective teaching of programming have been highlighted. While it may not be possible to implement every option on trial, it is instructive in constructing a better teaching/learning environment for any programming language course. By taking into consideration the course and entire curriculum objectives, the profile of the students and other available resources, this can be done.

This paper has highlighted the following preferable practices for effectiveness:

1. Simple, structured and generally applicable programming language
2. Simple development environment with minimum levels of abstraction away from the working of the compiler
3. Effective practical sessions.
4. Other teaching interventions.

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