FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

EDUCATIONAL TECHNOLOGY: THE NEXUS OF THE 21ST CENTURY EDUCATION AND BEYOND

By

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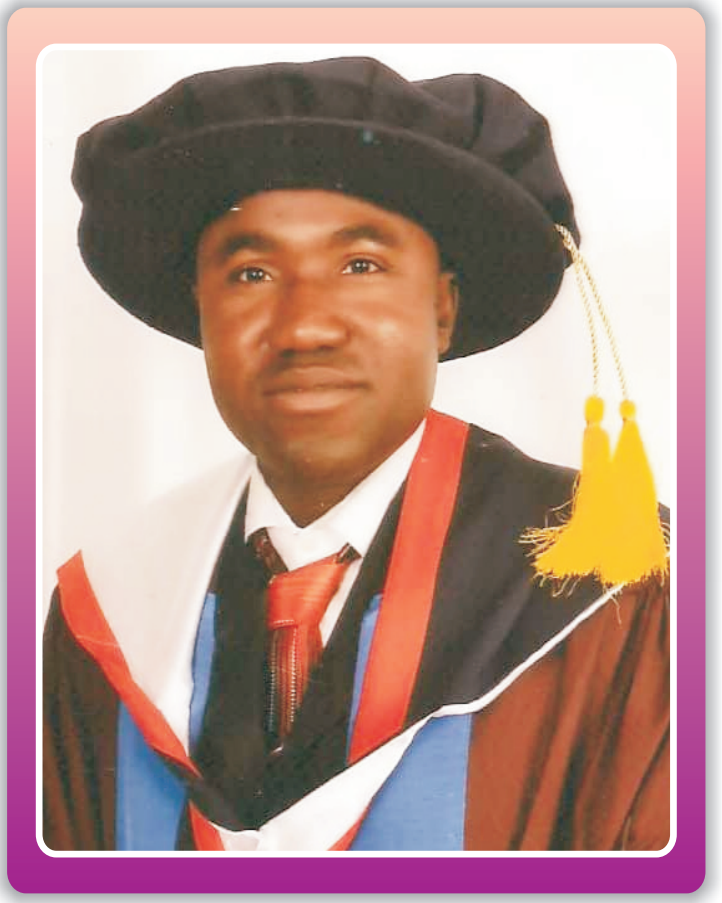

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EDUCATIONAL TECHNOLOGY: THE NEXUS OF THE 21ST CENTURY EDUCATION AND BEYOND

1.0 Overview of Educational Technology

The essence of education globally is to assist individuals to maximize their potentials for optimum self-development and the development of the society. Therefore, education is a prerequisite for an individual to attain self-reliance and the greatest instrument for any meaningful and sustainable national development. Thus, the Federal Government of Nigeria adopted education as an instrument par excellence for effective national development (FGN, 2013). The role of education in the 21st century is not just inculcating knowledge in students but also the skills they need to survive and bring about positive changes in society. It involves technology driven education designed to prepare and equip humans for acceptable, profitable, and worthwhile life in any community where they may find themselves (UNESCO, 2014).

Educational technology refers to the use of tools, technologies, processes, procedures, resources, and strategies to improve learning experiences in a variety of settings, such as formal learning, informal learning, non-formal learning, lifelong learning, learning on demand, workplace learning, and just-in-time learning. Various terms have been used to refer to educational technologies, such as learning technologies/environments and instructional technologies/systems.

Association for Educational Communications and Technology (AECT) defined Educational Technology as the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources (Januszewski & Molenda, 2008). In elaboration of the AECT definition, we note that designing, adapting, customizing, implementing, testing, deploying, and evaluating resources, activities, learning and instructional tools intended to facilitate learning, performance, and instruction are included within the scope of the discipline.

1.1 Evolutional Trend of Educational Technology

The historical development in the field of Educational Technology could be categorized into four major phases, namely: Stone Age Period, The Age of Book and Chalkboard, Mass Communication Era, and Information and Communication Technology Age (Spector & Ren, 2015).

Stone Age Period: This begins with the early men who lived inside caves. Though stack illiterates, they were able to make some drawings on the surfaces of rocks and other flat objects. Writing on leaves and tree trunks, engraving on metals and rocks are the beginning of writing technology. This implies that the early men are the progenitors of Educational Technology discipline. The use of stones, pebbles, slates, or slabs, counting sticks and bottle caps as is done in many primary schools of today are regarded as the replica of the early man's period.

The Age of Book and Chalkboard: In 1456, Johann Guttenberg developed the printing machine that printed the first Bible. With this invention, the art of printing spread widely and other books were produced. This development provides the teacher with a place to write down important points, diagrams, and symbols.

Mass Communication Age: The invention of the radio and the television marked the beginning of mass communication and by implication, mass education. The two media became two good sources to reach the hitherto unreachable and the less privileged in the society. Indeed, the radio served this purpose better than the television.

The Information and Communication Technology Age: The advent of the computer technology has unified all communication media available to man. It came with some developments such as Electronic board, Multimedia system equipped, CD/DVD-ROM player, video conferencing, voice recognition/communication devices for the special education students, digital camera, virtual reality, virtual libraries, virtual lab, virtual universities, avatar-based immersive environments, cloud computing, among others. The rapid expansion of technologies that represent the historical trends of educational technology is shown in Figure 1.

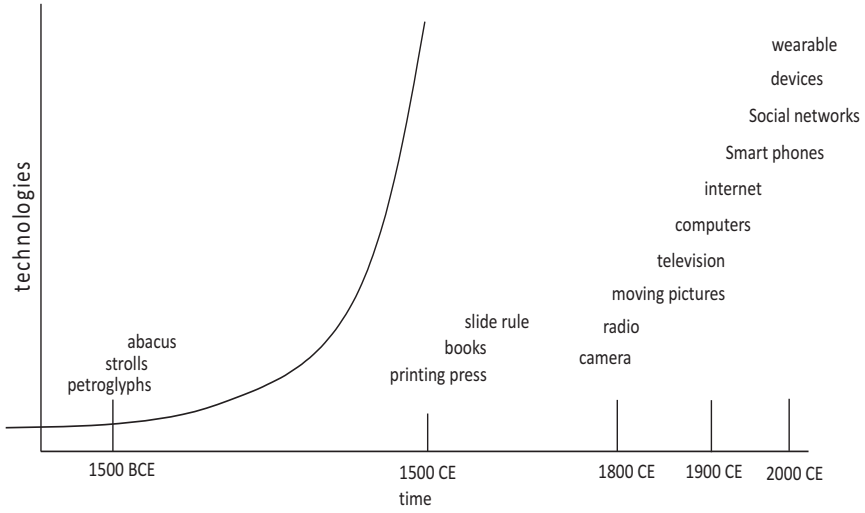

Figure 1: Historical trends of rapid expansion of Educational Technologies

1.2 Scope of Educational Technology

The scope of Educational Technology is eclectic in nature and difficult to tread. It is a dynamic, complex, and interdisciplinary enterprise. It is dynamic because of rapid changes occurring in technology. It is complex because of the many interacting factors, components, and people involved in an education system or learning environment; moreover, many of the relationships among those factors, components, and people are nonlinear and change over time. Educational Technology is inherently an interdisciplinary enterprise involving, content experts, technical specialists, teachers, and administrators among others, who have different backgrounds and formal training (Hartley *et al.,* 2010). For this lecture, Educational Technology can be categorized into the following five scopes: Technological Research and Applied Science, Educational Planning Technology, Educational Management Technology, and Educational System Technology, Information and Communication Technology.

Technological Research and Applied Science: This scope centers on the result of massive investments in research and development. It emphasizes the functions of design of research about evaluation, selection and utilization of resources (people, materials, facilities, equipment, and activities) involved in any teaching-learning process. It involves both the psychological perspective of applied science and technological research and development perspectives. This scope covers the professional roles of curriculum supervisors, media consultants, instructional developers and staff developers.

Educational Planning Technology: This scope involves questions of socio-economic needs and the organization and administration of financial, materials, and human resources needs to satisfy them. Here attempt is made to involve the active participation of all groups concerned with formal education, that is, researchers, school functionaries, film makers, media experts,

publishers to deploy self-instructional materials efficiently and convert schools into "resources for learning" centres. The meaning here corresponds to the role of the Educational Planner.

Educational Management Technology: This scope focuses on the management of educational media, including such related activities as an organisation and personnel management, logistics, utilization and dissemination. Here, emphasis is placed upon the problem-solving process whereby resources, including the organization itself are acquired, stored, retrieved, and distributed to achieve an educational result. The corresponding manager-technologist role of director and instructional materials manager are delineated.

Educational Systems Technology: This scope is the application of system analysis to teaching and learning. It enables the teacher, researcher, research worker or administrator to isolate meaningful problems, select appropriate strategies for dealing with them and then determine the effects that these strategies could or do have on the working of the overall educational system. This scope regards educational technologist as educational problem-solver. The scope corresponds to the role of the expectations of educational system developer. Educational Technology experts must use technology to solve educational problems as the need arises and their solution must satisfy conflicting requirements.

Information and Communication Technology: This scope emphasizes the production of instructional materials and communication. It is the application of technological tools which have been primarily developed for other purposes. Aside for the teaching machine, which was deliberately involved as an educational tool, other electronic devices like, television, projectors, iPad, computers, networks were all developed for markets outside educational circle. These devices have since been adapted and integrated into 21st century education.

This scope covers the role of graphic artist, photographer, cinematographer, computer programmer and television director. The ICT tools adapted for teaching and learning are shown in Figure 2.

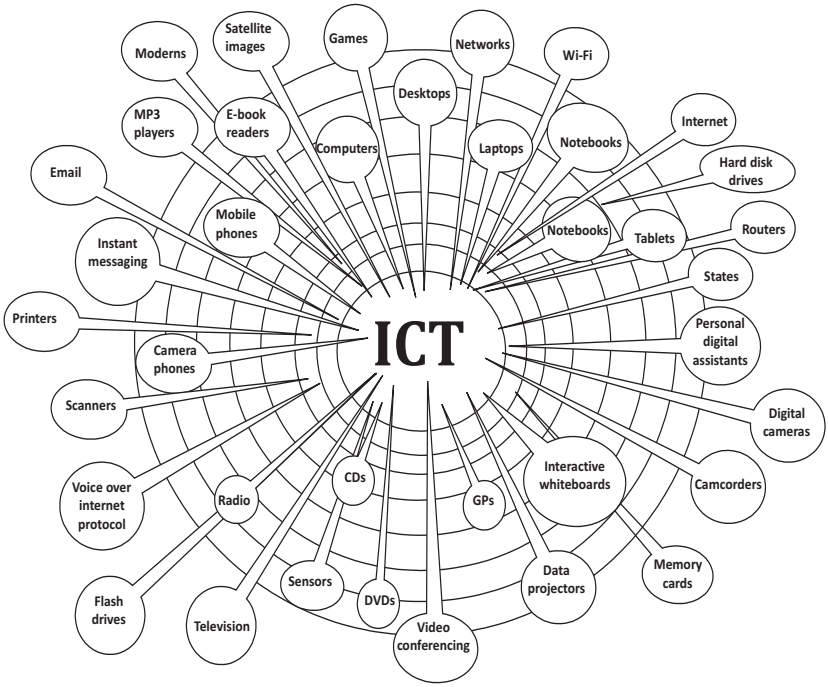

Figure 2: ICT technologies adapted for teaching and learning purposes
Source: *Anderson (2010)*

2.0 Twenty-First Century Education

The 21st century is the contemporary century of the Anno Domini era or Common Era, following the Gregorian Calendar. It began in Janauary1, 2001, and will end on December 31, 2100. It is the first century of the 3rd Millennium which is also synonymous with the Digital Information and Technology generation.

2.1 Generations within Twenty-First Century

The century comprised of four different generations and each has a different approach to technology and life which must be noted. The "**Silent Generation**" comprised those born before 1946 (75 years old and above), who were not raised with modern technology. Next to that is the "**Baby Boomers Generation**" (**Digital Immigrants**) which is a generation of those born between 1946 and 1964 (between 57-75 years old), at the advent of computer technology. Following this is the "**Generation X**" (**Digital Natives**), a generation of those born from 1965-1980 who may be between 41-56 years old. They are the first to be computer literate. The next is the "**Net Generation**" (**Digital natives**), which is the generation of those born after 1980 (from 41 years and below, as of today). They are born with modern technology and they communicate technologically via the internet and social media (Tapscot, 2009). Irrespective of the generations, there are certain skills required to become relevant and succeed in the century.

2.2 The Twenty-first Century Skills

The 21st Century skills are the competencies that students nowadays need to acquire to succeed in their careers. According to UNESCO (2016), the skills are sub-divided into three as shown in Table 1.

Table 1: Twenty-first century skills

Learning Skills (4Cs)	Literacy Skills (IMT)	Life Skills (FLIPS)
Critical thinking	Information literacy	Flexibility
Creative thinking	Media literacy	Leadership
Collaborating	Technology literacy	Initiative
Communicating		Productivity
		Social skills

These skills can further be categorized as hard skills, soft skills, and go-getting skills. The Hard skills belong to the realm of cognitive intelligence and they emphasize reasoning analysis and communication competencies. Soft skills are a mixture of intra-personal and intra-personal competencies and are in the domain of emotional mastery and control that enable us to function as team players. With the go-getting skills, the domain of imaginative intelligence, one can be entrepreneurially creative. Today's world of work demands a combination of each of the three sets of skills. The employers' ranking of skills required for employment is presented in Table 2.

Table 2: Employers' ranking of skills required for employment

Skills	Mean	Rank
Communication (verbal & written)	4.69	1
Honesty/Integrity	4.59	2
Teamwork skills	4.54	3
Interpersonal skills	4.50	4
Strong work ethics	4.46	5
Motivation and initiative	4.42	6
Flexibility/adaptability	4.41	7
Analytical skills	4.36	8
Computer skills	4.21	9
Organisational skills	4.05	10
Detail-oriented	4.00	11
Leadership skills	3.97	12
Self-confidence	3.95	13
Friendly/outgoing personality	3.85	14
Well-mannered/polite	3.82	15
Tactfulness	3.75	16
GPA (3.0 or better)	**3.68**	**17**
Creativity	3.59	18
Sense of humour	3.25	19
Entrepreneurial skills/risk-taker	3.23	20

Source: *Job-interview-site.com (Employability Skills Checklist)*
http//www.jobinterviewsite.com

2.3 Technologies for the 21st Century Pedagogy

Pedagogy simply means methods of teaching, learning and assessment. The recent advancement in teaching, learning and assessment has placed a great deal of emphasis on the acquisition of 21st century skills driven by technology. The lesson delivery approaches and learning environments have been diversified and modernized. Teaching no longer depends on the use of Blackboards (BB), White Board (WB), but uses SMART Boards, or even 'No Board' (such as Computers, Laptops, iPods, iPads, Tablets, SMART Phones, SMART TVs among others). Teaching and Learning (T&L) no longer take place just within the "four corners of a brick-and-mortar classroom" but does happen effectively as well outside. Teaching and learning could be face-to-face, online, offline basis or blended in both real and virtual environments. The advent of e-Learning has revolutionized education and pulled down many barriers to learning such as geographical, class size, distances, race or ethnic nationality, gender, among others (UNESCO, 2014; Yalam, 2016).

2.3.1 Technologies for teaching: The delivery is fast changing from "Time-based Education and Training (TBET) to Competency-Based Education and Training (CBET). Technology supports a variety of teaching strategies (such as learner-centered or personalised learning, collaborative learning, inquiry-based learning, project-based learning, flipped classrooms), thereby, improving access to electronics resources; providing a variety of resource formats including text, images, audio, video, and animation to make learning innovative, interactive, and engaging to students. Furthermore, technology enhances and extends learning environments such as display technologies in the classroom to improve face-to-face learning environment as well as extend the learning environment to an online environment using Internet connections and technologies such as learning platforms. It also allows the extension of the learning environment to a mobile environment using mobile

technologies. Presently, technology is used to support continuous professional development to access online courses, to collaborate and communicate with technologies to reach global and regional online communities and create learning networks and communities of practice.

2.3.2 Technologies for learning: Technology supports a variety of learning strategies such as Active learning, Independent learning, and Informal learning. It improves access to learning using the Internet and mobile technologies at any time and from any location. Also, it enables the choice of the pace of learning by students using ICT tools such as e-learning courses or simulations to learn at the pace that suits them. Different learning styles are accommodated by using a variety of digital resource formats such as text, image, audio, video, simulations, games, quizzes, and demonstrations, among others. Students' motivation and engagement are improved by using a variety of active and engaging electronic resource formats such as videos, games, simulations, and social media tools. Similarly, it supports the development of 21st century skills. Learning with technology helps in developing learners' ICT skills and by learning how to use technology effectively, they can develop other 21st century skills while using technology in the learning process.

2.3.3 Technologies for assessment: Today, the assessment and evaluation of learners' performance in school subjects have changed in many developed countries from content-based assessments to performance-based; also, most examinations have changed from pencil on paper to Computer-Based Testing. The method of certifications has also changed to National or Regional Vocational Qualifications (NVQ) which creates an opportunity for job mobility thereby boosting employment opportunities among teaming unemployed youths in those regions (UNESCO, 2014).

Technology supports a variety of assessment strategies such as diagnostic assessment, formative assessment, summative assessment, formal assessment, informal assessment, self-assessment, peer assessment, and collaborative assessment. We use technology for an online survey for diagnostic assessment to determine a student's current abilities or progress. An online quiz, simulation or game can be used for self-assessment. Blogs can be used for peer and collaborative assessment. Similarly, technology provides a variety of formats such as text, images, audio, animation, and video to make assessment appealing and engaging for students. Technology enables re-use by providing assessment formats and collaborative tools that enable assessment to be easily shared and re-used so as to reduce workload. A range of authoring tools enable students to demonstrate their knowledge and skills by creating content in different formats. Students can also update their work easily and share their work using tools like online storage, social networks and learning platforms. Nowadays, the teacher uses technology to assess a wider range of skills using different assessment types such as electronic portfolios, simulations, games, and virtual worlds to allow students to demonstrate skills that go beyond the physical walls of the classroom. Finally, technology improves assessment management by using digital tools such as spreadsheets, databases, learning platforms, plagiarism detection software, and communication tools to manage submissions, markings, storage and communication of results. Also, online assessment tools for teachers include, Socrative, Google Forms, Mentimeter, Poll Everywhere, and Kahoot - game-based assessment tool.

2.3.4 Teachers' roles in the Twenty-first Century: Technology has changed the role of teachers in this dispensation. Therefore, teachers at all levels of schooling should be prepared for such radical change otherwise, they will be caught unawares.

This is because students have already embraced technology and are waiting patiently for their teachers to catch up. The role of the teacher is being transformed from one of primary dispensers of knowledge to one of facilitators of learning. The teacher now provides information in the context of a rich learning environment, in which the student is an active learner. Rather than the teacher telling the students what they are to learn, the teacher sets up an environment where the students can be active in acquiring knowledge and skills using appropriate technology tools (Gambari & Yusuf, 2015). Presently, teachers should have the ability to collaborate effectively with others, being potential users of, and taking advantage of technology such as social media, for educational purposes. Teachers should acquire vast knowledge of network of digital learning communities, become innovators and facilitators with diverse knowledge of modern teaching strategies supported by technology. Teachers should become critical thinkers, researchers, and problem solvers, among others. These roles would assist them to effectively integrate the technological tools into education. Twenty-first century has changed teaching and learning approaches from the old teaching methods to new ones. These paradigm shifts of instruction have influenced the roles of teachers as shown in Table 3.

Table 3: Old and New Paradigm Shifts of Instruction

Old Paradigm	New Paradigm
Teacher-centered instruction	Student-centered learning
Single sense stimulation	Multi-sensory stimulation
Single path progression	Multi-path progression
Single media	Multimedia
Isolated work	Collaborative work
Information delivery	Information exchange
Passive, receptive learning	Active, inquiry-based learning
Factual, knowledge-based	Critical thinking informed decision making
Reactive response	Proactive, planned
Isolated, artificial context	Authentic, real-world context

To prepare students for their future after formal education, teachers must continue to seize every opportunity to integrate technology to improve student learning outcomes. The following are the top ten technologies for 21st century instruction, Social Networking, Gamification, Mobile Devices, Digital Electronic Books (eBooks), Digital Video/Videoconferencing, Electronics Response Systems, Simulation Technology, Podcasting, Lecture Capture Apps, 3-D Printing & Apps (Tomei, 2017).

3.0 Technology Integration in the 21st Century Education

Technology integration is defined as the use of technology to enhance and support the educational environment. Effective integration of technology is achieved when students can select technology tools to help them obtain information promptly, analyze and synthesize the information, and present it professionally. Technology should become an integral part of how the classroom functions. To achieve this, there should be policy formulation, implementation, and practices (Yusuf, 2013). Figure 3 shows the components of transformative technology integration.

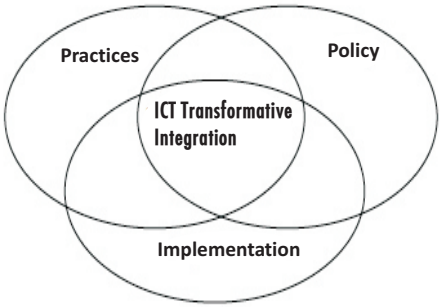

Figure 3: Components of transformative Technology integration
Source: *Yusuf (2013)*

As shown in Figure 3, the policy will inform implementation and practices. The policy provides a sound basis for assessment and evaluation. These three components must be addressed at the

macro, meso and micro levels. Macro deals with national ICT policy development, implementation, and practices. Meso deals with the state, local government, or school policy development, implementation, and practices. Micro, however, entails individual teachers' implementation and practices based on the conception of learning. These major areas should be critically examined. Government has made the following policies towards the ICT Development in Nigeria:

(i) Launching of the National Policy on Computer Literacy at Primary, Secondary and Tertiary levels of education in 1988
(ii) Launching of the National Telecommunications policy (September, 2000)
(iii) Development of a comprehensive Science and Technology policy. (2001)
(iv) Development and launching of the National Information Technology Policy (2001)
(v) Establishment of the National Information Development Agency (NITDA) (2001)
(vi) Launching of the Nigerian Satellite Systems Programme by the NASRDA (2001).
(vii) Development of the National Infrastructure Backbone (NIIB)
(viii) Development and launching of the Mobile Internet Units for schools in remote areas.
(ix) Establishment of Rural Internet Resource Centres (RIRC) in the six geo-political zones

All these policies would translate to nothing without adequate implementation and practice. There are factors that could lead to ICT transformative integration in Nigeria. The success factors for effective technology integration are generally classified as human factor, leadership, technological, pedagogical, and course/programme factors (Menchaca & Bekele, 2008; Yusuf, 2013). These factors and their elements are shown in Figure 4.

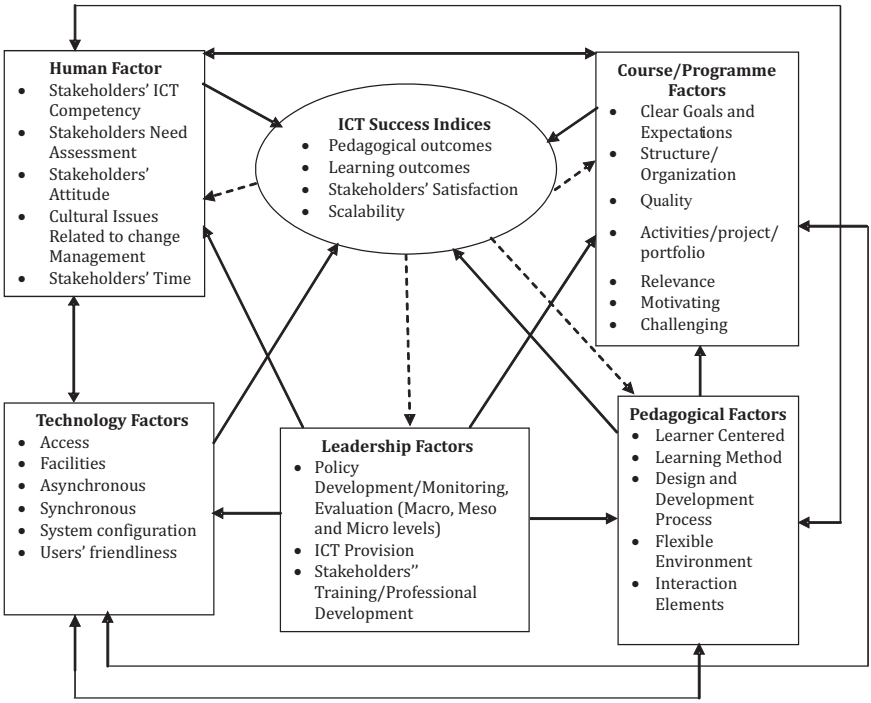

Figure 4: Adapted model of success factors in technology transformative integration

Source: *Adapted from Menchaca and Bekele (2008) and Yusuf (2013)*

The figure shows that the interplay, and inter-relationships among human, leadership, technological, pedagogical, and course factors in ensuring successful technology application are complex, yet they need to be taken care of to ensure success in technology integration.

3.2 Problems Associated with Technology Integration in the 21st Century

The presenter agrees with Yusuf (2013) and Vikoo (2019) on the challenges confronting technology integration in the 21st century pedagogy in Nigeria schools as follows:

1. Teacher factor: Many Nigerian teachers lack basic ICT and fundamental technological skills to integrate technology into the instructional process. Many are resistant to change and are yet to embrace ICT. In addition, Nigerian teachers are poorly paid, and these unfavourable working conditions may cause frustration and reluctance in integrating technology into classroom activities.

2. Unreliable electricity supply: Electricity is intermittent and most schools are not connected to the national grid, therefore, insufficient power supply becomes a major impediment to the adoption of 21st century pedagogy.

3. Poor economy and its effects: Most Nigerians cannot afford simple digital resources, therefore, they do not have access to computer-based telecommunication facilities and this makes it difficult for schools to access and integrate required online services.

4. High cost of ICT facilities: Most educational institutions in Nigeria lack adequate computers and other ICT-related equipment. However, the few who have access to the Internet are unable to retain the access because they cannot afford to pay for Internet hosting rights, as well as to maintain and sustain ICT facilities.

5. Shortage of ICT experts: In many schools, there is a severe shortage of qualified ICT experts in the areas of application software, operating systems, network management, and technicians who can perform routine maintenance and minor repairs.

6. Epileptic Internet Services: Internet services are extremely limited and expensive and this makes the integration of telecommunication in the delivery of 21st century pedagogy in Nigeria a difficult task.

7. Inadequate software with local content: There is scarcity of educational software that is relevant to Nigeria curriculum. Those that may be adaptable are expensive due to high foreign exchange rates and artificial scarcity created by intermediaries.

8. Outdated curriculum: Most Nigerian curricula are not technologically inclined to meet the 21st century learners' skills.

9. Instability and unreliability of technology: The dynamic nature of technology causes a rapid turnover of technical tools and techniques, rendering them obsolete in a short time.

10. Lack of maintenance culture: Most Nigeria's public schools are neglected and under-maintained and some equipment is rotting away in their initial containers.

All these constraints can be intimidating and discouraging, but they should serve as a reminder that education in this dispensation requires unconditional commitment from all the stakeholders. We can decide to leverage on the potentials of technology towards achieving 21st-century skills through vision, improvisation, and determination. We should design and develop indigenous software packages that can improve our curriculum.

4.0 Instructional Material and Software Package Development Process

Problems remain unsolved until someone feels dissatisfied with the prevailing state and takes necessary action to improve it. The development of instructional software package starts when the educational stakeholders are not satisfied with the end products (e.g., students' performance) or they feel dissatisfied with the strategies and tools employed in teaching and learning. Therefore, there is a need to design, develop, apply and manage appropriate technological processes and resources to facilitate

meaningful learning and improve students' performance.

The development of educational software requires teamwork and a systematic approach guided by instructional system design models. The following are the stages of the instructional software package development process (Huang *et al,* 2019).

1. Needs Assessment: This includes Need analysis, participant analysis, content analysis among others. How is the need determined? What problems are we trying to solve? who decides what should be done? A needs assessment is a way to identify symptoms and causes resulting in a clear and coherent statement of the problem to be addressed.

2. Requirements and Feasibility Analysis: A requirement analysis creates a framework for a solution approach. An early feasibility review of the requirements is considered, and a simple prototype should be constructed early in the design process, while a more robust feasibility study can be conducted to confirm that what has been planned is accomplished (Rossett, 2009).

3. Design / Redesign: Designing and planning learning activities, selecting, and sequencing resources, creating units of instruction, and determining formative and summative assessments are typical tasks to be accomplished as the package is being designed. The design, planning and implementing involves (a) What to teach (content to be learned), (b) how to teach (strategies and activities to promote understanding and mastery), and (c) how to identify things to do differently (evaluation of the course with the potential to improve subsequent versions).

4. Development: The development process usually involves the content, storyboard and courseware developments by team of

specialists (e.g., content, media, educational technology system analysis and computer programmer). Therefore, a systematic approach is adopted and prototype would be developed and tested internally, one or more times before being passed on for development. (Reeves, 2006). Any problem with the implementation can be discovered and addressed during development.

5. Deployment / Implementation: Field trial testing is a tryout of the software package with a small but representative group of students. Such a trial field test will likely result in a need to make changes in the design and/or the development of the software package. Installation and distribution of software package as well as monitoring learners' activities are parts of the implementation

6. Management: The management of the software package is usually handled by the system administrator and the content expert who monitors students' progress, reports their performance outcomes, perceptions, and reactions; and finally reports any problem to the educational technology team.

7. Evaluation: Evaluation of software package involves administering of Pre-test and post-test, usability survey, and results comparison between those exposed to the use of the software and those taught without package. Evaluation also includes summative and formative evaluation.

8. Support: All the team members are to be involved in providing support for the software package (online or offline) because students need to know whom to call when they encounter problems. Tutors and staff support personnel need to be trained to properly support the new software.

9. Training: The key personnel need to be trained early and

continue throughout the design, development, and deployment of the software package. Training the students before implementing the software will enable them to know what is expected and perform all the necessary actions and activities required in the software. Inadequate preparation and training of key personnel may lead to failure in software implementation (Hartley *et al,* 2010). The instructional material and software package development process is shown in figure 5.

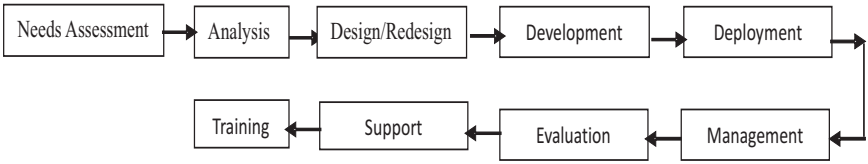

Figure 5: Instructional material and software package development process

5.0 My Contributions

Mr. Vice-Chancellor Sir, permit me to delve into my contributions. In addition to the Educational Technology courses that I have taught within and outside this University, I will present the following contributions to the knowledge of technology applications and packages developed to overcome learning difficulties in sciences and other subjects; research evidence confirming the effectiveness of technology in classroom instruction; different psychological constructs (attitude, interest, motivation), and moderating variables (gender, ability, age, among others) that could influence students' learning outcomes.

5.1 Teaching Contributions

I have taught the following undergraduate courses: Introduction to E-Teaching, Introduction to E-Learning, Mobile Learning Technologies, Intranet and Extranet, Instructional Communication Model, Media Principles and Techniques, Non-Projected Graphic Communication, Research Methods and Data

Processing, Techniques for Production of Inexpensive Instructional Material, Programmed and Computer-Assisted Instruction, and Computer in Education.

Besides, I have also taught the following postgraduate courses: Application of Computer in Education, Operation and Maintenance of Media Equipment, Seminar, System Approach to Problem Solving, Graphic Communication in Instruction, Administration of Instructional Media Centre, Instructional Cinematography, Radio and Television Production, System Design, History of Educational Technology, Advanced Study of Innovative Technology, Resources Management, Curriculum Development and Implementation, Advanced Techniques of Script Writing, Google Education, among others. All these courses have contributed towards preparing the undergraduate pre-service and postgraduate teachers for knowledge and skills required for technology integration in the 21st century education

5.2 Research Contributions

5.2.1 Development of educational software packages for improving learning outcomes

Mr. Vice-Chancellor Sir, I wish to present some of the software packages developed, validated, and assessed for improving teaching and learning in the 21st century in the course of this lecture. My research established that Educational Technology involves product, process and evaluation of instructional materials. Some of these include the development of Virtual Laboratory, Computer Simulation, Edutainment, Flipped Classroom, Mobile Learning Application, Gamification, Podcast and Vodcast, Electronics Response System, Web-Based Learning, Web-Quest Package, Computer-Assisted Instructional Package, Computer-Assisted Pronunciation Package, Computer-Supported Collaborative Learning Package, Screencast Instructional Package, EduBlog, Micro-Blogs, Multimedia

Instructional Package, Learning Management System (Moodle), Presentation Packages, and Infographics package, among others. I shall now focus on the development and evaluation of a few of them.

5.2.2 Development of Virtual Laboratory Software Package: Mr. Vice-Chancellor Sir, it is not unusual to find students in many secondary schools who have never witnessed regular chemistry laboratory preparations of simple compounds, such as Hydrogen (H_2) and Carbon (IV) Oxide. The lack of instructional materials, science laboratory equipment and facilities have been highlighted in the literature (Gambari, 2011, Gambari & Yusuf, 2016a), resulting in underachievement/unsatisfactory performance in the science subjects.

In addressing the problems, Gambari *et al.,* (2012) developed the virtual laboratory for teaching secondary school physics students in Minna, Nigeria. Findings revealed that students using physics virtual laboratory performed better than those taught with physical laboratory because they were opportuned to repeat the experiment several times at their own pace. In another study, Gambari *et al.,* (2018) developed a virtual laboratory instructional package for teaching practical chemistry to secondary school chemistry students in a collaborative learning environment. Again findings revealed that the use of virtual laboratory improved chemistry students' performance by 95% compared to conventional practical approach.

5.2.3 Development of Computer Simulation: Many biological concepts are abstract, difficult for teachers to teach and difficult for students to understand, which is inversely responsible for poor academic performance in both internal and external examinations. In an attempt to overcome the abstractness of biology concepts, Gambari *et al.,* (2013a)

developed a computer simulation instructional package for teaching digestive system in Biology at the senior secondary school level in Nigeria. Similarly, Gambari and Ikusanu (2014) investigated the efficacy of Computer-Based Simulation on students' achievement in Physics Education. Findings revealed that students taught with our computer simulation performed better than their counterpart taught with the conventional teaching method with a major difference of 93.7% compare to traditional method of teaching. Computer simulation presented the concepts in a concrete form that promotes better understanding and motivates students to learn.

5.2.4 Development of Edutainment Instructional Package: The love of music, sports and other entertainment such as African magic movies, Facebook, Twitter, WhatsApp, Instagram, Telegram among others, has preoccupied students' attention and reduced focus on education. Therefore, entertainment sometimes, has a negative effect on the academic performance of students (Fenta & Kelkay, 2018).

To avert students' attention from negative forms of entertainment, Nwokocha *et al.,* (2020) developed an edutainment instructional package for teaching Biology at senior secondary school in Abuja, Nigeria. Findings revealed that students exposed to edutainment in collaborative learning settings performed 90% higher than their counterparts using traditional method. This performance could be attributed to students' active participation, communication and collaboration among their peers. In another study, Saliu *et al.,* (2020) developed an edutainment instructional package for teaching Economics at senior secondary schools in Niger State, Nigeria. Findings revealed that edutainment greatly improved students' performance by 98% the reason being that the game-based edutainment aspect of the package allows students' active

participation, entertainment and provides immediate feedback.

5.2.5 Development of Flipped Classroom: The 21st century pedagogy involves students' engagement, communication, collaboration and interactions (student-student, teacher-student, and student-technology) to ensure effective learning. Teaching science subjects in the Nigerian classroom is mostly by teacher-centred approach, which invariably lead to passive learning, boredom, and poor performance. This outdated instructional delivery method calls for the adoption of 21st century teaching approaches such as a flipped classroom. Therefore, Gambari *et al.,* (2016a) developed a flipped classroom for teaching Mammalian Skeletal System concept in Biology. The students in the flipped classroom group outperformed their counterparts in the conventional method of teaching group. In Physics, Abolarinwa *et al.,* (2021) developed a flipped classroom instructional model for teaching physics at secondary school in a collaborative learning environment. The failure rate in English language examinations prompted Gambari *et al.,* (2021d) to develop flipped classroom for teaching Oral-English at senior secondary schools in collaborative learning settings. In these studies, the results indicated that students taught using flipped classroom in collaborative learning strategies performed better by over 90% than those taught using individualised learning strategy and conventional methods. The superiority of flipped classroom strategy over other approaches was a result of students' engagement, interaction, and collaboration. The video package used in flipping the class allows students to pause, rewind, re-watch, and create a ready-made library for review, make-up work, among others.

5.2.6 Development of Mobile Application: Nowadays, the technology revolution is stealing away the youth from worthwhile education. Smartphone technology is a distraction

and has been frustrating intellectual scholarship, especially in developing nations. Students spend valuable time on phone, iPad, or other mobile devices, watching movies, listening to music, tweeting, sending text messages, and sharing pictures on Instagram. These time-wasting activities do not promote learning, and adversely affect their academic performance. Instead of confiscating these mobile devices and punishing them for their use in the classroom, students should be guided on the positive use of these devices to promote learning Owolabi *et al.,* (2017). This is achievable by sharing PowerPoint presentations or the lecture materials to their devices. Alternatively, students can download the content and other useful materials from the Internet. They can assign to use mobile devices to record presentations and classroom interactions. This will de-emphasise the over-dependent on traditional methods of instructional delivery.

To enhance effective teaching and learning with digital technological tools in the 21st century, there is a need to develop mobile applications to facilitate online learning or blended learning in Nigerian tertiary institutions. This phenomenon encouraged Owolabi *et al.,* (2017) to develop a mobile application for teaching Biology at Colleges of Education in Nigeria. The findings revealed that students exposed to mobile application for learning Biology performed better than their counterparts using the individualised learning approach and traditional method. The superiority of mobile apps in collaborative learning settings was attributed to access to learning materials anytime, anywhere, and sharing ideas and resources among peers. Gambari *et al.,* (2021f). developed a mobile application for teaching computer science at Kaduna Polytechnic, Kaduna, Nigeria. The use of mobile application to augment classroom instruction provides a huge difference (96.3%) between those taught with it and those taught without

it. The reasons being that students with mobile application also attended the conventional class and used mobile application with unlimited learning resources to augment their learning.

5.2.7 Development of Gamification: In many Nigerian classrooms, students are not physically and mentally engaged in the teaching and learning process because of the non-use of digital technologies that promote engagement, social interaction, entertainment, active participation and immediate feedback. Whenever students are not actively and meaningfully engaged in learning, boredom sets in, resulting in poor performance. In one of our studies, we discovered that different games such as video game, computer game, Playstation Portable (PsP), among others, are common among Nigerian youths which negatively impact their academic achievement. This became worrisome; therefore, Ajanaku *et al.,* (2019) developed and assessed a gamification instructional package on the concept of genetics for senior secondary schools' achievement in Minna, Nigeria. In a similar study, Gambari and Nwokocha (2021) investigated gamification's impact on students' performance in Ecology among Senior Secondary School students in Abuja, Nigeria. The gamification package developed was similar to a TV programme "Who wants to be a Millionaire". We found that students exposed to gamification instructional strategy outperformed those taught with the conventional teaching method, the reason being that students were fully engaged, actively participated will highly motivated and received immediate feedback. The finding revealed an excellent performance better by (over 98.9%) by students taught using gamification against their counterparts in conventional teaching methods.

5.2.8 Development of Electronic Response System: Overpopulation and overcrowding in Nigerian classrooms in all public schools is responsible for poor participation, poor

classroom management, low interaction and collaboration among students and teachers in higher institutions. Students usually feel bored and are absent-minded due to the abstract nature of some concepts and the use of teacher-centred teaching approach. This could be one of the major factors responsible for poor performance. Therefore, Gambari *et al.,* (2021c) developed and assessed a mobile electronics response system (MERS) for teaching Computer Science in Colleges of Education in South-West Nigeria. The finding revealed that pre-service teachers exposed to MERS in a collaborative environment performed better with 84.8% than those in the individualised learning group. This was a result of the influence of MERC, active participation and collaboration among students.

5.2.9 Other Studies on Software Packages

We discovered that students in higher institutions in Nigeria always use the mp3 player/iPod and other devices anywhere and anytime which has adverse effects on their CGPA. This phenomenon motivated Salaudeen *et al.,* (2016) to develop and determine the efficacy of Podcast on Nigerian Certificate of Education (NCE) Biology Students' Achievement in Individualised and Collaborative Settings. In another study, Balogun *et al.* (2019) developed Podcast, Vodcast, and Enhanced podcast for teaching physics at senior secondary schools in Abuja. Similarly, Gambari and Badmos (2019) created a screencast and vodcast for teaching Mathematics in senior secondary schools in Niger State. In all these studies, students taught using vodcast outperformed their counterparts in a podcast by 78.7% while podcast was 85.4% than screencast respectively.

Twenty-first century pedagogy emphasizes the use of digital technology especially online and blended learning. We discovered that Web-based instruction is one of the student-

centred strategies yet to be integrated into teaching and learning in most Nigerian classrooms. Our motivation to solve this problem led Anunobi *et al.,* (2017) to develop and validate Web-Based Courseware for Junior Secondary School Basic Technology Students in Nigeria. It was found that students exposed to web-based instructional strategy performed better than their counterparts taught with conventional teaching methods. Similarly, Ojoye *et al.,* (2019) determined the impact of Moodle platform for teaching Basic Technology students in Niger State, Nigeria. The finding revealed that the Moodle platform improved students' performance by 88.9% over conventional teaching method. In another study, Gambari *et al.,* (2017a) investigated the effectiveness of blended learning and E-learning modes of instruction on undergraduates' performance in Kwara State, Nigeria. The findings revealed that students taught using blended (96.2%) and online learning (73.5%) performed better than those taught the conventional teaching method.

We discovered that EduBlogs is one of the approaches that promote online classroom interaction and collaboration between teacher to student and student to student. Based on this, Gambari *et al.* (2021a) developed and evaluated the impact of three modes of mobile blogs on pre-service teachers learning outcomes in woodwork technology in College of Education in North-West Nigeria. Findings showed that pre-service teachers' taught using video-blogs scores were 86.9%, those taught using audio 75.2% and text 67.5% blogs, respectively.

Globally, social media has positive and negative effects on Net-generation students. In Nigeria and other developing countries, students at higher institutions are addicted to social media and they are mostly wasting valuable time and not paying attention to their studies. This scenario motivated Gambari and Ofoka (2019) to create Facebook, WhatsApp, and Twitter group accounts as microblogs instructional packages for teaching Biology pre-service teachers in

Colleges of Education in North-central Nigeria. The findings revealed that microblogs were useful as an augmented instructional delivery strategy among pre-service teachers in Colleges of Education and was 96.1% better than using lecture method alone.

The need and agitation to imbibe 21st century technology tools that will lead to students' success and personalized learning motivated Namadi *et al.,* (2019) to develop and evaluate WebQuest's impact on teaching pre-service teachers' Geography education courses in Colleges of Education in North-West Nigeria. The study found that the Geography pre-service teachers' performances above 90.01% compared to those taught without Webquest because they were exposed to abundant learning resources in the subject.

The need for students to learn and progress at their own pace, work individually, cooperatively or collaboratively to solve a problem, and receive immediate feedback could not be obtained in the conventional classroom environment in Nigeria. Therefore, Gambari *et al.,* (2013b), Gambari and Yusuf (2013c), Gambari and Yusuf (2014), Gambari *et al.,* (2014f) to develop a Computer Assisted Instruction (CAI) package for teaching and learning physics and mathematics among secondary school students in Minna metropolis. We discovered that students performed better when taught using the CAI package in cooperative environment than individualised learning setting. The CAI package was superior to the individualized setting and conventional teaching method because CAI encourages social interaction, engagement, active participation, self-pace learning, and immediate feedback.

5.3 Impact of Technology Integration on Educational Variables

Mr. Vice-Chancellor Sir, some educational variables play vital roles in influencing students' performance irrespective of

subjects. Here, we shall discuss how technologies were deployed in solving teaching and learning difficulties in the classroom based on variables such as students' academic performance, knowledge retention, gender, ability/achievement levels, attitude, and motivation.

5.3.1 Effects of technology on students' academic achievement

Students' poor performance has been a great concern to education stakeholders (teachers, parents, government, private sectors, administrators, policymakers, educational experts, among others) of decades in Nigeria, students' academic achievement in the sciences (Biology, Chemistry, Physics) at senior secondary education has been fluctuating as reflected in the statistics analysis by the West African Examination Council (WAEC, 2006-2020). Students' performances are generally below expectations even with advent of *"miracle centres"* across the country. Figures 6 revealed the students' performance in core science subjects in Nigeria.

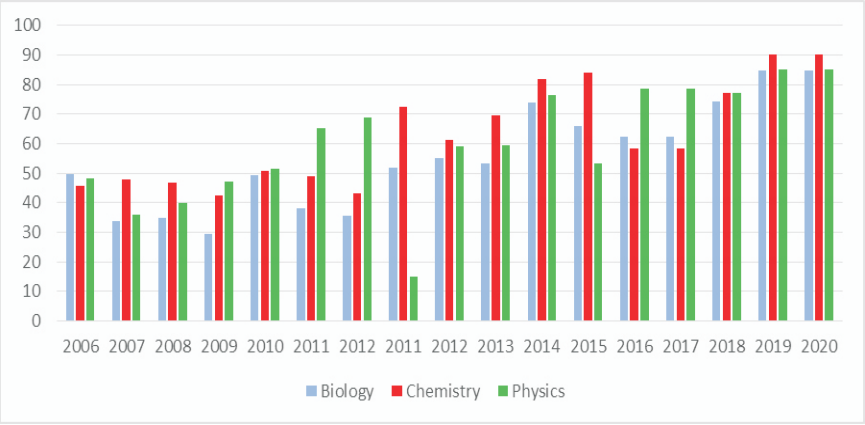

Figure 6: Students performance in Biology, Chemistry and Physics (May/June WASSCE, 2006-2010) in Nigeria

Source: *Research and Statistics Unit (WAEC, 2021)*

Figure 6 revealed that the percentage of students that passed Biology, Chemistry and Physics at credit level and above (A1-C6) was consistently less than 50% from 2006 to 2010 in Nigeria. In 2011 to 2015, students performance in Chemistry were better than that of Biology, while in 2016 to 2020, we witnessed improvement in Chemistry and Physics where students performance were above 70%. From the figures, the performance has been fluctuating in all the three major science subjects. The observed fluctuation in students' performance in the sciences becomes a matter of grave concern to the nation and science education. This undulating is very disturbing and, if not checked, may affect students' enrolment in tertiary institutions, not only in science education but also in other science and technology-related disciplines. This has serious implications for national development particularly in areas of security, economy and human resources in the 21st century.

One of the major causes of students' poor performance, especially in science, is poor instructional strategies and inadequate technology integration for classroom instruction (Gambari *et al.,* 2013c; Abolarinwa *et al.,* 2020, Nwokocha, *et al.,* 2020). As Educational Technologists we have conducted several studies on technology integration to improve students' academic performance across many subjects. In 2013, Gambari *et al*., (2013d) investigated the effectiveness of computer-supported Jigsaw II cooperative learning strategy on senior secondary school students' performance in Physics. In 2014, Gambari *et al.,* (2014c) determined the comparative effect of two modes of computer-assisted instructional packages on Solid Geometry achievement. Similarly, Gambari *et al.,* (2016c) investigated the effectiveness of web-based instruction on junior secondary school students' performance and retention in Basic Technology in Niger State. In 2020, Nwokocha *et al.,* (2020) determined the effectiveness of edutainment on secondary school Biology

students' achievement in Abuja, Nigeria. Gambari *et al,* (2021b) examined the mobile blog's impact on woodwork technology pre-service teachers' achievement in North-Central Nigeria. All these studies favoured the use of technology over the traditional method of teaching. Table 3, for example shows the achievement of students taught using web-based technology and those taught with a traditional method.

Table 3: Students' performance in Basic Technology using Web-based and conventional method

Variable	Pre-test (%)	Post-test (%)	% Difference
Web-based Learning	19.80	80.53	60.73
Conventional Method	18.34	41.05	22.71

Source: *Fieldwork Report (Gambari et al., 2016c)*

5.3.2 Influence of technology towards improving students' knowledge retention of instructional content

A series of studies on the impact of students' knowledge retention using technology across many subjects have been conducted. In 2008, Gambari and Zabairu investigated Videotape's impact on achievement and retention in primary Science among primary pupils in Niger state. In 2014, Gambari *et al.,* (2014d) investigated secondary school students' achievement and retention through video-based multimedia biology instruction. In another study, Gambarı and Yusuf (2015) determined the Effectiveness of Computer-Assisted STAD Cooperative Learning Strategy on Physics Problem Solving, Achievement and Retention. Gambari and Yusuf (2016) investigated the effects of computer-assisted Jigsaw II Cooperative Learning Strategy on Physics achievement and retention. Owolabi *et al.,* (2017) investigated the effects of the mobile app on biology pre-service teachers' achievement and retention in North-central Nigeria Colleges of Education. Furthermore, Gambari *et al.,* (2016a) determined the impact of flipped classroom instructional model on students' achievement

and retention of Mammalian Skeletal System in Minna, Niger State, Nigeria. The findings from each of the studies revealed that the students taught using technology performed and retained better than their counterparts taught with other conventional methods. Table 4 compares from one study, the knowledge retention of students taught using technology and those taught with the traditional method.

Table 4: Posttest and retention scores of Physics students using Jigsaw II cooperative and individualized learning strategies

Variable	Post-test (%)	Retention test (%)	Difference (%)
Computer-Assisted Jigsaw II Cooperative Learning	68.38	63.02	5.36
Individualized Computer Instruction	61.39	56.47	4.92

Source: *Field work Report (Gambari & Yusuf, 2016)*

5.3.3 Effects of technology in eliminating gender differences in students' achievement

According to UNESCO estimates, 130 million girls between the age of 6 and 17 are out of school in Sub-Saharan Africa. It also reported that less than a third of girls in that region are enrolled in secondary schools. Despite the low level of female enrolment in secondary school, the male performance also outweighed female performance (UNESCO, 2014). Studies on the influence of technology on gender disparity in students' performance were carried out by many researchers. In 2017, Gambari *et al.,* (2017b) determined the effects of virtual laboratory on the achievement levels and gender of secondary school chemistry students in individualised and collaborative settings in Minna, Niger state. In 2021, Gambari *et al.,* investigated Flipped classroom's influence on male and female students' performance in Oral-English. In Computer Science course, Babatunde, *et al*., (2021) determined the influence of Mobile Electronic Response System between male and female pre-service students' performance in Colleges of Education in South-West Nigeria. Saliu *et al.,* (2021)

determined Edutainment's influence on male and female Economics students' performance in Minna, Niger State. The findings revealed that technology integration enhanced the performance of male and female students irrespective of the subjects. One of the factors responsible for equal performance between male and female students could be the availability, accessibility and utilisation of technology devices for learning. Table 5 shows the difference between male and female students performance using virtual laboratory instructional software package from one study.

Table 5: Male and female students' performance in virtual laboratory instructional software package

Group	Pre-test (%)	Post-test test (%)	Difference (%)
Male	24.17	75.50	51.33
Female	23.83	74.00	50.17

Source: *Field Work Report (Gambari et al., 2017b)*

5.3.4 Impact of technology in bridging the gap among students' ability levels

Students with different ability or achievement levels constitute the composition of an ideal classroom. In the conventional classroom setting in Nigeria, students with varying ability levels (High, Medium and Low) are put together in the same classroom. They are given the same instruction without considering their learning ability. Studies on ability levels found that high-ability students performed better than medium and lower ability level students (Gambari, 2011). On the contrary, (Thomas & Feng, 2014) in their study found that ability grouping did not affect student achievement. Findings from the research literature on the effects of ability on student achievement in Science have been inconclusive. Various studies were conducted to determine whether technology for teaching would bridge the gap among the

low, medium and high achiever students. Gambari *et al.,* (2013e) investigated the efficacy of video-based cooperative learning strategy on high, medium and low academic achievers. Gambari, *et al.,* (2014) conducted a study on bridging the gap between low, medium and high ability students through Computer-Based Multimedia Instruction. Gambari *et al.,* (2016d) also determined the effects of Computer-Based STAD Cooperative Learning Strategy on the Performance, Achievement Level and Attitude of Secondary School Physics Students in Minna, Nigeria.

Furthermore, Hussaini *et al.,* (2017) investigated the effects of Computer-Assisted Instruction on secondary school mathematics students' spatial visualisation ability, achievement and attitude in Niger State, Nigeria. The findings revealed that high, medium and low achiever students exposed to instructional packages performed better and achieved similar results irrespective of subjects in collaborative learning environments. The results can be explained by the fact that the high achievers monitor medium achievers learning, while medium achievers assist low achievers to learn better. Table 6 shows the difference among the high, medium, and low achiever students using technology and those taught with conventional methods.

Table 6: Students' performance in Mathematics based on ability levels using video instructional package

Methods	Group	Pre-test (%)	Post-test test (%)
COOVIP	High	25.45	86.56
	Medium	19.92	86.01
	Low	15.67	85.89
COMPVIP	High	24.09	78.20
	Medium	22.34	74.80
	Low	14.87	71.00
IVIP	High	25.09	75.40
	Medium	23.19	71.40
	Low	19.57	68.20

Source: *Fieldwork Report* (Gambari *et al.,* 2013e)

5.3.5 Influence of technology in improving students' attitude toward learning

Psychologists confirmed that our attitudes affect what we tend to do and what we tell ourselves to do. Therefore, if we have negative attitudes, these negative attitudes affect what we expect of ourselves, affecting our actions. A negative attitude limits performance and inhibits learning. There is a positive correlation between attitude towards learning and academic achievement (Shaibu, 2014). Studies have revealed that students' attitude towards the methods of instructional delivery influenced their academic achievement. There is also an assertion that students in a technology-rich environment experience positive and improved effects on their attitude and achievements in all major subject areas.

In 2013, Gambari *et al.,* (2013f) investigated the efficacy of virtual laboratory on the achievement and attitude of secondary school students in Physics practical. Gambari and Yusuf (2013a) did a similar study on enhancing Physics students' retention and attitude using a computer-supported team assisted individualisation strategy. Gambari *et al.,* (2016f) explored the effects of the Computer-Self Interactive Package (CSIP) on Students' Performance, Achievement Level and Attitude toward Mathematics at the Secondary School Level in Nigeria. Gambari and Yusuf (2017) determined the relative effectiveness of computer-supported Jigsaw II, Student Team Achievement Division (STAD) and Team Assisted Instruction (TAI) cooperative learning strategies on performance, attitude and retention of secondary school students in Physics.

Furthermore, Balogun *et al.,* (2017) examined students' attitude towards Interactive Whiteboard, PowerPoint, and Chalkboard for Learning Basic Technology. Gambari and Yusuf (2013b) investigated Nigerian secondary school students' attitudes toward cooperative learning strategies. From each of these studies, it was found that technology integration positively

influences students' attitude to learning and therefore enhanced students' academic performance. Based on our findings and other similar findings on Technology's perspective, it is recommended that teachers should integrate technology to promote students' positive attitude so as to improve academic achievement and retention. Table 7 shows the difference in students' attitude taught using technology and those taught with the conventional method (Chalkboard) as revealed in one of these studies.

Table7: Students' attitude towards Technical Drawing using IWB, PPT and Chalkboard

Variable	Pre-Attitude (%)	Post-Attitude (%)
Interactive Whiteboard	25.45	95.56
PowerPoint Presentation	24.09	82.23
Chalkboard	24.99	64.07

Source: *Fieldwork Report* (Balogun *et al.,* 2017)

5.3.6 How technology motivates students to learn

Motivation is one of the factors that drives and sustains learning behaviour. Motivation to learn is one of the most important predictors of academic success. Students can be intrinsically or extrinsically motivated to learn. Intrinsic motivation refers to internal desires to perform a particular task rewarded by completing the job itself, while extrinsic motivation refers to a task's performance to receive an external reward (Ryan & Deci, 2010). It was predicted that students who had high extrinsic and intrinsic motivation concentrate, and are dedicated to learning compared to their lower extrinsic or intrinsic motivation counterparts. Invariably, this influences academic achievement of students irrespective of subjects.

Gambarı *et al.,* (2015b) investigated the effects of Computer-Assisted STAD, Learning Together Model (LTM) and Individualised Computer Instruction (ICI) Cooperative Learning Strategies on Nigerian Secondary School Students' Achievement,

Gender and Motivation in Physics. In 2016, Gambari *et al.,* (2016e) examined the impact of Intrinsic and Extrinsic Motivation among Chemistry Students using Computer-Assisted Instruction. Nwokocha *et al.,* (2021) studied Edutainment's influence in promoting intrinsic and extrinsic motivation of secondary school students in Biology. The outcome of these studies revealed that technological tools enable intrinsic and extrinsic motivation. Since our reviews agree with findings from other studies, we recommended that technology integration in the classroom could motivate students to learn and achieve academic success. Table 8 reveals the difference in the attitude of students taught using technology and those taught with the traditional method (Gambari, *et al.,* 2016e).

Table 8: Students' level of intrinsic and extrinsic motivation using CAI and conventional method

Method	Motivation	Pre-motivation (%)	Post-motivation (%)
Computer Simulation	Intrinsic	32.92	94.08
Package	Extrinsic	33.01	91.78
Computer Tutorial Package	Intrinsic	34.08	88.94
	Extrinsic	32.99	87.03
Traditional Teaching Method	Intrinsic	33.62	57.02
	Extrinsic	32.78	50.15

Source: *Fieldwork Report* (Gambari *et al.,* 2016e)

5.4 My Contributions to the Community Service

Mr. Vice-Chancellor Sir, I will like to share my contributions in the area of community social responsibilities. I have categorized this into four major areas namely: Research Funding, Supervision, and Awards; Curriculum Development, Policy Formulation and Assessment; Public Speaking and Committee Membership.

5.4.1 Research Funding, Supervision and Awards: Mr. Vice-Chancellor Sir, I won a research grant from Kaduna State Government on development of virtual laboratory for teaching Chemistry at secondary schools in Kaduna. On supervision, I have supervised over 100 undergraduate research projects, 65

Masters degree (M.Tech. & M.Ed) and 17 PhD from FUT, Minna, ABU, Zaria, and University of Ilorin. On Merit and Academic Awards, I emerged as the best Corps member in Kogi State in 1999 I have represented the University at various innovation and exhibition fora at local and national levels and won a 3rd place award under the Education category among Nigerian Universities during the 6th NURESDEF Expo at Nnamdi Azikiwe University, Awka, Anambra State, in 2016.

5.4.2 Policy Formulation, Curriculum Development, and Assessment: Under the supervision of Prof. J. O. Odigure, I developed the ODL policy for CODeL in 2011, which was approved by the Senate and Council. In 2013, I led the Committee that produced the Curriculum for the establishment of Educational Technology Department in FUT, Minna. In 2014, I worked with Prof. M. O. Yusuf to develop the Curriculum for the establishment of three new undergraduate programmes (Computer Education, Industrial and Technology Education, Fine Arts Education) at University of Ilorin which two were approved by NUC. In 2020, I worked with Prof. J. O. Odigure at the Council for the Regulation of Engineering in Nigeria (COREN) to develop the Accreditation Manual for Engineering Programmes in Nigerian Universities. I have served as an External Assessor for the appointment and promotion of high-level academics in various tertiary institutions in Nigeria. Similarly, I served as an External Examiner for Undergraduates projects moderation, Masters and PhD Oral examinations in universities within and outside Nigeria. Still on assessment, I have participated in various Accreditation Exercises organised by NUC.

5.4.3 Public Speaking: Mr. Vice-Chancellor Sir, within the last few years, I have featured and have been invited as Lead Paper Presenter, Guest Speaker, Resource Person, Panelist, Moderator among others to various events. These have given me opportunity to share my views and knowledge with those within and outside the four walls of the university. I have used such

opportunities to proffer solutions to existing problems and further enlighten the audience on relevant areas as expected at such occasions. These occasions include: Millennium Development Goal (MDG) workshop for science teachers in Niger State, Workshop for Staff of the Office of the Accountant General of the Federation, Corporate Affair Commission, Federal Ministry of Finance, Train the Trainer workshops at CODeL, Prize Giving and Award Ceremonies among others.

5.4.4 Committee Membership: Mr. Vice-Chancellor Sir, I served as a member in more than 40 committees at the Department, School/Faculty, and University levels. I was a member of the Web Content Committee established by Prof. M. A. Akanji. Based on the Committee's efforts, the University webometric ranking increased from 57th to 23rd. It later rose from 13th to 7th to 6th and presently the 12th best University in Nigeria and 1st among the specialized universities. With the Committee's efforts, the University repository, E-mails for staff and students, staff profiles, sub-domain sites for Journals were created. Web-masters were employed, undergraduate projects were uploaded to the University repository, and courseware synopsis was made mandatory and uploaded to the University website.

6.0 My Future Research Direction

Mr. Vice-Chancellor Sir, my future research direction will focus on the new trends in Educational Technology. Five trends are shaping the future of work. These are. (i) New Behaviours (shaped by social media and the web); (ii) Technologies (shift to the cloud, Collaborative technologies, big data, the Internet of Things (iii) The Millennial Workforce (new attitudes, expectations and ways of working); (iv) Mobility (work anytime, anywhere, and on any device); and (v) Globalisation (no boundaries). In all the above mentioned, Technology is the prime mover and a significant factor in how education in the future differs from education today.

My research efforts will help to develop market-ready prototypes for all the completed research works in the short term. For the on-going research, efforts will be to complete them. The emerging technologies will be fully explored, assessed, and integrated into Nigerian school systems in the medium term. Such technologies include: Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Bring Your Own Device (BOYD), Cloud Computing, Artificial Intelligent, 3D printing, Hologram, Biometrics, Internet of Things (IoT), Advanced Robotics, Commonplace, Smart Houses, Wearable Computers, Holodeck, and Individualised Education

The long-term future direction will be to collaborate with mechatronics to develop Artificial Intelligence and robots for teaching face-to-face and online classrooms. Also, efforts will be made with the assistance of nano-technology in producing nano-technology digital devices for teaching and learning, among others.

7.0 Conclusion

Mr. Vice-Chancellor Sir, I wish to submit that every century comes with different challenges. Education is a useful tool to overcome these challenges. Our education products will solve no problems if technologies meant to support innovative teaching and learning are not available for the use of teachers and students at all levels of education.

There are many challenges and difficulties in integrating Technology in schools. The needed facilities are not available, political backing, steady electricity, and dependable infrastructure as well as adequate funding for education to thrive are all insufficient. Addressing these challenges is necessary if Nigeria is to join the global world in providing skills for our citizens to compete favorably in a global economy. Presently, we are producing unskilled graduates who cannot think outside the box, who cannot create jobs but rely on unavailable white-collar

jobs. The present curriculum also does not focus on the 21st century skills that could lead to growing youth population out of unemployment. "How then do we deal with these challenges?"

This lecture has taken cognizance of educational technology as a discipline with its potential to revolutionize the country's entire educational system. Technological tools and resources could assist in individualized learning, collaborative learning, and help to ensure effective interactions among education stakeholders. They could help facilitate unrestricted access to quality education hitherto limited by distance, gender, physical disability or other family and socio-economic commitments. Also, the multi-modal affordance of ICT would help ensure high-speed and quality pedagogical delivery. The ravaging Covid-19 pandemic that has thrown the entire world into a state of panic has necessitated the need to pay more attention to Educational Technology.

Mr. Vice-Chancellor Sir, distinguished ladies and gentlemen, you have made a tremendous contribution to this lecture by your presence. By this lecture, I believe that we have collectively laid a good foundation on which practical approaches to 21st century education in Nigeria can be built. You are no longer a spectator, but an active participant, an agent of change, someone who could help advocate for the integration of Technology towards achieving 21st century skills.

8.0 Recommendations

The following are recommendations to overcome the current educational challenges and for the adoption of 21st century global best practices:

1. Teachers should be encouraged to embrace 21st century pedagogy and integrate modern digital technologies into their instructional processes. Therefore, government and educational stakeholders should provide adequate digital literacy training for teachers to enable them to integrate

technology for effective instructional delivery in the 21st century.

2. There is a need to restructure the existing curriculum at all school levels to reflect 21st century thinking and best global practices.

3. Government and non-governmental organisations should procure and deploy adequate ICT facilities at all levels of Nigeria's educational system in order to compete academically with its counterparts globally.

4. Federal Government should remove tax on importation of digital technology devices for education sector.

5. Government should provide adequate technical support for planning, implementation and troubleshooting when technical problems occur.

6. Students should be guided on the positive use of mobile technology devices to promote effective learning. This is achievable by sharing learning materials to their devices, recording lecture presentations, downloading other relevant learning resources, among others.

7. Professional organisations such as Educational Media and Technology Association of Nigeria (EMTAN), Association for Innovative Technology Integration in Education (AITIE), and other related bodies should drive reforms in using technology to transform Nigerian educational system towards 21st century education.

8. The Educational technology programme in higher institutions should be redesigned to emphasise both teachers and students' activities to learn via the deployment of digital learning tools such as the Google Classroom, Prezi, Quizlet, etc.

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Gambari, Amosa Isiaka was born on the 25th February, 1971 into the family of late Alhaji Suleiman Amosa Balogun Gambari and Alhaja Hadeeza Balogun Fulani of Ilorin East and Ilorin South Local Government Area of Kwara State, Nigeria.

Gambari Amosa Isiaka completed his primary education from Pake Local School Management Board (LSMB), Ilorin, Kwara State in 1976. He started his secondary education at Bishop Smith Memorial College, Ilorin in 1980. He however, changed to Government Technical College, Ilorin where he studied Electrical Technology and obtained the WAEC (Technical) Certificate, Federal Craft Certificate, Federal Ministry of Labour Certificate of Competence (Grade IIII & II) in 1986. In 1990, he gained admission into the Department of Technical Education, Kwara State College of Education, Ilorin in 1988 to study Electrical/Electronic Education, which he completed in 1991. He worked briefly at FSTC Shiroro, Kuta, Niger State and proceeded to University of Ilorin to study Educational Technology in 1993. In 1997, he completed his HND in Public Administration from Kwara State Polytechnic. He served at Kogi State during the National Youth Service Corps (NYSC) and was awarded the best Corps member of the year in the State in 1998. He obtained his PGD Computer Science and M.Tech in Educational Technology from Federal University of Technology, Minna in 2003 and 2004, respectively. He completed his PhD in Educational Technology from University of Ilorin in 2011.

Professor Gambari is respected locally and internationally as an authority in his field. He has served the Federal University of Technology, Minna meritoriously in various capacities for the past fifteen years, even in addition to his tasks as a teacher. He has supervised many Post Graduate Diploma in Education (PGDE) candidates' research projects, and over 90 undergraduate research projects. After 10 years of obtaining PhD, he has supervised over 45 Master's degree theses and 17 PhD theses from FUT, Minna, ABU, Zaria

and University of Ilorin. He has served on several committees, panels and boards established by the University and has worked closely with all the past Deans of the School of Science and Technology Education and the Directors of Centre for Open and Distance e-Learning (CODeL), Federal University of Technology, Minna. Prof. Gambari has served the Federal University of Technology at 18 different occasions as Chairman of various Committees, 29 times as members of various Committees at Departmental, School and University levels.

Prof. Gambari was appointed Departmental Examination Officer (2007), School Assistant Examination Officer (2010), Head, Instructional Design Unit of CODeL (2011); Managing Editor, JOSTMED (2011-Date); Deputy Dean of SSTE (2016-2018); School Web-Master (2016); Deputy Director, CODeL (2017-2020), Acting Director, Centre for Open and Distance Learning (CODL) at University of Ilorin (2013); Editor, Journal of Information, Education, Science and Technology (JIEST) (2018), He is a reviewer to many Journal outlets within and outside the country.

Prof. Gambari has authored several books and Chapters in books. He has over 130 scholarly articles in local and International conferences and journals of repute. His sterling qualities and abilities have been recognized and tapped beyond the Federal University of Technology, Minna. He served as a Guest speaker and resource person at various workshops and seminars. He was a member of the National Universities Commission (NUC) Programme Accreditation Team to many universities. He served as an External Examiner for both Undergraduate and Postgraduate projects and theses. He has represented Federal University of Technology, Minna at local and national Trade Fair, Exhibition and Expo. He served as Assessor of Principal Lecturers and Associate Professor at various Colleges of Education, Polytechnics and Universities. Prof. Gambari is a member of many professional bodies. He is married and blessed with children

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