

**ENHANCING COMPUTER-BASED MUSIC ASSESSMENT THROUGH MULTIMEDIA
INTEGRATION: AN EXPLORATIVE APPRAISAL OF JAMB AND OTHER NIGERIAN PUBLIC
EXAMINATION BODIES**

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ABSTRACT

The rise of artificial intelligence (AI), the importance of public examinations, and the ongoing challenges facing assessment systems underscore the need for digitally-driven approaches to restore public trust and ensure the reliability of these exams. It is evident that the assessment of Music by Nigerian public examination bodies lacks the impactful integration of multimedia, such as innovative and interactive Music items enabled by Information and Communication Technology (ICT). This absence of innovation in Music assessments has negatively affected the credibility of Nigeria's examination bodies and diminished candidates' cognitive and aural skills. To date, the National Examinations Council (NECO) and the West African Examination Council (WAEC) have not adopted technological tools for Music assessment. Although the Joint Universities Preliminary Examination Board (JUPEB) and the Joint Admissions and Matriculation Board (JAMB) have introduced computer-based Music assessments, these processes remain vulnerable to human interference and potential manipulation of musical scores. Currently, Nigerian high-stakes examination bodies still lack interactive and innovative Music items in their assessments. This paper takes an expository approach, advocating for the adoption of innovative technologies and digitalization in Music assessment. The research outlines the components and benefits of technological innovations in assessment digitization, concluding that 21st-century digital assessments and enhanced technological controls are critical to ensuring credible high-stakes exams. The paper recommends that NECO and WAEC introduce Computer-Based Testing (CBT) for Music assessments while retaining Paper-Pencil Testing (PPT) for theory, and calls for the inclusion of interactive and innovative Music items across all current and future high-stakes examination bodies, rather than relying solely on limited notation software.

KEY WORDS: Music, CBT, Multimedia, High-Stakes examinations.

INTRODUCTION

The integration of innovative testing methods through Information and Communication Technology (ICT) is essential for Nigerian high-stakes examination bodies to align educational advancements with effective assessment practices. When new technologies are incorporated into assessments, they enhance the ability to measure complex skills and reasoning processes more accurately.

The introduction of Sibelius (named after the Finnish composer Jean Sibelius) and Finale software into the Computer-Based Testing (CBT) for Music in the assessments conducted by the Joint Universities Preliminary Examination Board (JUPEB) and the Joint Admissions and Matriculation Board (JAMB) has significantly improved public examinations in sub-Saharan Africa.

Initially, JAMB used Finale software for notating musical scores but later switched to Sibelius due to its superior educational and editing capabilities. Other examination bodies, including JUPEB, the West African Examination Council (WAEC), and the National Examinations Council (NECO), have since adopted similar technologies, moving away from the manual method of drawing Music notes. Sibelius has proven to be more flexible for Music education and JAMB's testing processes.

However, WAEC and NECO have yet to fully transition to Computer-Based Testing (CBT) and may begin by applying CBT to objective questions, while leaving theoretical parts for Paper-Pencil Testing (PPT).

This paper highlights the value and security advantages that multimedia-based assessment methods offer. The use of multimedia in Music assessments strengthens security and enhances the technological tools designed to combat exam malpractice.

As noted by Adesipe (2016), 21st-century assessment should involve the evaluation of a student's overall performance using technologically enhanced controls when necessary. This view aligns with Anikweze's 2012

conception of assessment as a process of evaluating the status or standard of the target subject in line with specific objectives, which Obioma (1998) also supports as a tool for making informed decisions about educational programs.

Assessment is a continuous process used by various stakeholders for different purposes. In this context, the goal is to develop new models of assessment that promote lifelong learning skills, enabling students to self-assess, reflect, and take an active role in managing their own learning from secondary to tertiary education.

Black and William (1998) emphasized that assessment activities adopted by teachers or educators are meant to support student learning. Educational assessment, therefore, involves documenting knowledge, skills, and attitudes in measurable terms.

The issue is not whether tests should be administered, but rather how they can be utilized effectively to track students' progress and support curriculum implementation. A good assessment must be valid, reliably measure what it is intended to measure, and consistently produce the same results with similar candidates.

These attributes are fundamental to the assessment methods used by Nigerian high-stakes examination bodies, which include psychometric analysis, moderation of exam items, and validation by subject experts. In some higher institutions, external assessments are conducted through the moderation of draft exam items by universities and subject experts. Adesipe's 2017 work, *Utilization of Information and Communication Technology (ICT) in Assessment Through the Use of Computer-Based Testing (CBT)*, corroborates the benefits of digitizing assessment processes.

He emphasizes that 21st-century assessment involves measuring learning outcomes and evaluating student performance using technological tools that not only aid cognitive development but also curb malpractice.

The digital transformation of education, enhanced by artificial intelligence (AI) and mobile learning through smartphones, has revolutionized teaching and testing. Traditional classroom settings are being replaced by digital processes like Distance and Open Learning Systems (DOLS), pioneered by institutions such as the University of Ibadan in Nigeria. Additionally, virtual classrooms now enable students to learn without geographical limitations, aligning with McLuhan's idea of the world as a "global village."

In modern classrooms, the barriers of physical space are dissolved, and technology continues to shape learning in and out of the classroom. With internet services enabling synchronous and asynchronous learning, both teachers and students must embrace these tools to enhance instruction and learning outcomes in the 21st century.

ASSESSMENT PROCESSES IN NIGERIAN HIGH-STAKES EXAMINATIONS

The assessment process by the Nigerian testing bodies can be categorized under four specific groups which are summed up as PASCORE:

- i. **Preparation**
 - ii. **Administration**
 - iii. **Scoring**
 - iv. **Reporting**
- i. **Preparation** demands that a test plan, a blue-print/a table of specification is developed to ensure adequate coverage of various aspects of the examination syllabi. With these steps in place, detailed specifications allow for the generation of appropriate items. Thereafter, workshops/conferences are held with test experts, school teachers and authorities in relevant disciplines. The items generated are reviewed and edited to seep out the inappropriate. The items are trial-tested on selected samples of candidate. Data are used for analyzing the items so that the final items for the examination can be selected. Later questions are organized in sets or forms after which specialists are invited to moderate the questions and printing of live questions are done. Some advanced bodies utilize CBT and item banking. Candidates are later invited to register so as to be eligible to sit the examination.
 - ii. **The Administration** is in parts. One has to do with the processing and distribution of candidates' details/data into their respective portfolios by the Information and Technology Services (ITS). Another one is the computation of the test items to the final level/camera-ready or student view and ready for uploading to the bank before they are administered.
 - iii. **The Scoring process** is the end of the assessment test and the beginning of the computation and analysis of candidates' responses. The mean is calculated and the highest scorer is determined. The responses are electronically recorded and assessed through the use of computers. This system

enables educators and trainers to author, schedule, deliver and access reports via the *World Wide Web* (WWW) or *Local Area Network* (LAN),

- iv. **The Reporting process** is the declaration of results after a combined meeting with the stakeholders in the testing industry.

TECHNOLOGICAL/RADIO-CONTROLLED ASSESSMENT AND OTHER ENHANCEMENTS

In the new information era, the methods of processing information have undergone a significant technological revolution, with its early stages being particularly impactful in education. The invention of computers and their related tools has brought about well-known advancements. It is therefore essential to examine the capabilities of computers in the following ways:

- i. Computers assist in lesson planning, organizing learning activities, and enhancing classroom presentations through the use of CD-ROMs and multimedia tools.
- ii. With the development and application of ICT in education, a notable step was taken in 2007 to introduce teaching through television, an innovation that continues to evolve (Adeyanju, 2009).
- iii. Computers support skill development by providing practice opportunities, generating tests, and offering electronic grade books, which are valuable for evaluating student performance.
- iv. Computers facilitate problem-based learning, promote interaction and collaborative learning, and serve as powerful motivational and management tools. These activities often require specific software.
- v. In 1999, Ghana universities once had the challenge of managing a growing student population, managing faculty, and limited teaching materials. In response, *Radio Windy Bay F.M. 98.3* was creatively utilized for teaching, marking the first use of broadcast media for education in tertiary institutions in Ghana. This innovation, pioneered by Prof. Lade Adeyanju of Obafemi Awolowo University (OAU), Nigeria, has since evolved into cost-effective online lectures delivered via radio.
- vi. Virtual websites are accessed through computers, offering additional educational resources.
- vii. OAU has implemented ICT tools that facilitate communication among staff, between staff and students, and between academic and non-academic personnel.
- viii. Other universities, including the University of Ibadan, Ahmadu Bello University, and the University of Lagos, have also adopted radio as a solution to some of their educational challenges (Adeyanju, 2013).
- ix. Resources such as the National Gallery of Art compact discs (CDs) and Windows on Science offer rich collections for teaching and learning.
- x. Multimedia combines text, sound, video, and graphics, allowing for the achievement of multiple
- xi. learning objectives.
- xii. At Obafemi Awolowo University in Ile-Ife, Osun State, a surge in students registering for the compulsory GNS course titled *Use of English* led to lectures being delivered via Closed Circuit Television (CCTV) in classrooms and auditoriums, allowing students to attend their lectures online comfortably.

ASSESSMENT DIGITISATION AND MULTIMEDIA CBT TEST ITEMS

The Joint Admissions and Matriculation Board (JAMB) became the first Nigerian high-stakes examination body to introduce Computer-Based Testing (CBT) under the leadership of Professor Dibu Ojerinde in 2013. Initially, this was implemented on a partial basis, but JAMB later transitioned fully to CBT in collaboration with the Dutch examination body, CITO.

The testing began with a Dual-Based Test (DBT) system alongside CBT, where DBT combined paper-based and computer-based components. In this format, candidates read questions on a screen while marking answers on an Optical Mark Readable (OMR) sheet. At this point, JAMB had also adopted Sibelius music software for notating musical scores.

The shift to digitization made it easier to secure exam content for reuse and allowed for greater variation in test versions. Although Sibelius software is not animated, it allows musical scores to be notated and inserted into tests using Microsoft Word after being snipped with the "Select Graphic" tool. Candidates are then required to carefully study the provided scores before selecting their answers. JAMB's CBT aims to improve examination administration, ensure more efficient scoring, enhance test security, and minimize exam malpractice. However, despite these advancements, JAMB's CBT has not yet fully utilized the potential of multimedia elements, particularly interactive Music items powered by Information and Communication Technology (ICT). Incorporating multimedia could further reduce malpractice and enhance the effectiveness of high-stakes assessments.

Multimedia components in CBT Music assessments would introduce a level of interactivity that traditional methods lack. Unlike static notations, where candidates must visualize the music internally, multimedia tools can play audio, engaging candidates' cognitive abilities and stimulating their aural perception.

Interactive Music items, powered by technologies like .NET framework and Flash Player, allow candidates to hear musical elements distinctly, which would be impossible using traditional notation methods like Sibelius, MuseScore, or Finale. This approach eliminates the need for candidates to mentally process unplayed notes and instead provides an environment where musical chords and parts (Soprano, Alto, Tenor, and Bass) are played audibly.

The result is a more dynamic and stimulating test environment, making the examination process less cumbersome and more enjoyable for candidates. The introduction of interactive Music items in JAMB's CBT would increase engagement, reduce human error, and create a more lively and immersive test-taking experience. These multimedia tools make assessments more real and interactive, significantly improving candidates' enthusiasm and interest. By allowing musical notes to be played on-screen, candidates experience a new dimension in learning and test-taking, leading to greater motivation and a deeper appreciation for computer-based music testing.

Additionally, using multimedia in CBT reduces the risk of exam security breaches, enhancing the overall quality and standard of JAMB's Music assessments.

Research by Huff and Sireci (2001) and Scalise and Gifford (2006) suggests that innovative test items are more engaging for candidates than traditional ones, and they can improve performance by enabling candidates to better demonstrate their relevant knowledge, skills, and abilities (i.e. KSAs). With multimedia tools, candidates can integrate visual and auditory cues with their analysis of musical elements such as chord progressions, intervals, and cadences.

This approach not only enhances the testing process but also minimizes irrelevant factors that could otherwise impact candidate performance. Ultimately, the use of multimedia in JAMB's CBT for Music creates a more engaging, effective, and secure examination process, benefiting both candidates and exam administrators.

DYNAMICS OF INNOVATIVE/INTERACTIVE MUSIC TEST ITEMS IN CBT MODE

Nigerian high-stakes examination bodies currently use Sibelius or Finale notation software for Music assessment, which incorporates multimedia elements into the computer-based testing (CBT) format. However, to make Music assessments more effective and results-driven, it is crucial to introduce Innovative/Interactive items. These items are computer-delivered and offer interactivity that traditional Paper-Pencil Tests (PPT) lack.

As noted by Kane (1992) and Zenisky and Sireci (2002), Innovative items have demonstrated significant potential in enhancing the quality, validity, and reliability of high-stakes assessments. These items are more engaging for students, test deeper levels of knowledge, align better with curricular approaches, and support the use of universal design and accessibility.

By reducing reliance on construct-irrelevant factors, such as reading load on non-reading tests, Innovative items improve construct validity. Additionally, they allow for detailed analysis of student interactions and can be designed for automated scoring, saving time and reducing the costs associated with manual grading.

According to Parshall, Davey, and Pashley (2000), Innovative items are uniquely suited to computer-based testing, offering interactivity that cannot be easily replicated on paper. These items often include features like drag-and-drop functionality or interactive stimuli within multiple-choice questions. They differ from the traditional multiple-choice format by aiming to test not just cognitive skills, but also affective, psychomotor, and perceptual abilities, such as recognizing musical intervals or cadences.

Interactive Music items are designed to generate multiple test items from a single source, such as a rhythmic pattern or melody, without altering the testing interface. These items facilitate both text-based and score-based constructed responses in CBT, reducing the likelihood of candidates guessing the correct answers.

To improve Music assessments in Nigerian high-stakes examinations, test developers should be encouraged to integrate animations and interactive elements. These tools would allow for more accurate testing of candidates' perceptual knowledge and cognitive abilities—something that is difficult to achieve with paper-based tests alone. Interactive Music items provide a dynamic, multimedia-driven approach that can be edited or proofread electronically, making the assessment process more flexible and adaptable.

Animated visual resources, including images and diagrams, can be incorporated into electronic formats, and scanned diagrams can be sent to software developers for further animation. As such, Music item writers must cultivate a strong understanding of computer technology to effectively develop these interactive elements. A

team of specialists, including software developers and multimedia designers, may be required to create these advanced Music assessment items under the CBT format. The specialists may include all or some of the following:

- Multimedia Designers,
- Animators,
- Programmers,
- Interactions Designers,
- Interface Designers,
- Graphic Designers,
- Audio Technicians.

These specialists or resource persons need to be actively involved in test development processes from the start to finish. This will make them the original copyright owners of their own generated items. For a successful production of computer-based Music assessment, it is vital that these specialists and different fields of expertise be included in the Test Development Department or Examination Development Department of Nigerian high-stakes examination bodies rather than transfer the contents of the assessment from one department to another. Innovative items are beneficial to candidates, testing bodies and public examining in the following ways:

- i. Measurement of a broader range of skills
- ii. Increased authenticity
- iii. Improved presentation of complex and dynamic information
- iv. Reduced reading load
- v. Increased student engagement
- vi. Reduced effect of successful guessing
- vii. Reduced demands on working memory, allowing for more valid measurement
- viii. Measurement of process skills and higher-order thinking

IMAGE USAGE IN INNOVATIVE/INTERACTIVE MUSIC TEST ITEMS

- i. Matching pictures of traditional musical instruments with words - helps with visual recognition
- ii. Candidates remember images of musical notes more than mere words - helps to retain knowledge
- iii. Images attract attention of users – they help in keeping the attention of a user and makes learning more real.

AUDIO USAGE IN INNOVATIVE/INTERACTIVE MUSIC TEST ITEMS

- i. Great for creating Music Tests as in ear training
- ii. Great for language translation Tests
- iii. Listening Tests - helps to develop listening skills e.g. aural training
- iv. Learning with audio can also help with developing communication skills
- v. Users can more easily recognize emotions
- vi. Users can absorb information while doing other tasks

VIDEO USAGE IN INNOVATIVE/INTERACTIVE MUSIC TEST ITEMS

- i. People are very familiar with videos, so this makes learning easier and fun
- ii. People remember what they see - helps to retain information
- iii. Can combine both audio and video
- iv. Makes tests more interactive
- v. Harder to understand information is easier to comprehend with the aid of video usage
- vi. People tend to pay attention more to video
- vii. Great for giving demonstrations
- viii. Great for testing observation skills.

Egberongbe (2012) highlights several key application tools based on *Macromedia Flash MX* technology that are instrumental in developing Interactive Music items. One such tool is the *Easy Test Authoring Tool*, available at <http://www.easyteach.com/easytest.html>. This tool simplifies the process of assembling screens by incorporating text, images, audio, and Flash content using pre-designed templates to maintain consistency. Typically, creating these screens involves cutting and pasting content from item documents and adding relevant images or diagrams, which can either be sourced from photo libraries or designed by the development team.

TECHNOLOGICAL FACTORS AIDING ASSESSMENT DIGITISATION IN HIGH-STAKES EXAMINATIONS AND SECURITY MEASURES

Adesipe (2017) notes the evolving integration of multimedia in Computer-Based Music assessments and the introduction of innovative/interactive Music items, aimed at restoring and boosting public confidence in digital assessments. To further support the effectiveness of these Interactive and Innovative Music Items, Adesipe

outlines several security measures and technological controls that are essential to the items and examination process as follows:

1. **Faraday Cage:** this is a metal built into the walls of a room to block electromagnetic waves. Mobile phones that are taken into the room would have severely reduced signals. This will rule out the use of the mobile phones for texting questions and answers in and out of the examination hall either by proctors or cheats.
2. **Global Positioning System (GPS):** this is a device that tracks calls and emails made from and to the administration blocks attached to the examination centers and the installation of signal jammers around examination centers.
3. **Biometrics Verification Machine:** with the aid of this machine, the fingerprints and even the blood of the candidates are all captured and recorded through the BVM. Some of the larger professional admission tests now require fingerprints to validate the identity of test takers. The Medical College Admission Test (MCAT), the Law School Admission Test (LSAT), the Graduate Management Admission Test (GMAT) and Graduate Record Examination (GRE) will be required to undergo a 'palm vein' scan which takes an infrared picture of the blood coursing through their hands. The image — which resembles a highway interchange in a major city — is unique to every individual. The scans are used widely in Japan among users of automated teller machines but only recently have appeared in the U.S.
4. **Collusion and hackers check** or other fraudsters through the use of specialized software. With this specialized software, hackers' interference is technologically tackled. Passwords may be changed at intervals of fifteen minutes. Anti-hackers' software may be downloaded from {www.assess.com}.
5. **Closed Circuit Television (CCTV) and Digitally Assisted Television (DATV):** helps in tracking down hoodlums wherever they may be within the vicinity of the examination. In this case, there is a control room where things are monitored and there is a security operative and expert available. All the events in the examination center are recorded and can be replayed to check up anything. Both events and time are recorded.
6. **GSM Jammer:** this machine works effectively with the conduct of computer based test. The hall is electrified such that once a candidate enters into the hall with mobile phones or any of its accessories; the detector makes an alert sound. If the phone is switched off before a candidate enters, it will never come up. If it is switched on before candidates enter, the jamming mechanism switches it off.
7. **Commercial Security Systems.** Some sophisticated systems provided by companies now integrate a number of test security services such as:
 - **Securexam Remote Proctor:** is about the size of a large paperweight and plugs into a standard port on a home computer. The sphere reflects a 360-degree view around the test taker, which the camera picks up. Students are recorded during exams and anything suspicious such as someone else presence or voice in the room is flagged.
 - **World Campus:** the online arm of the Pennsylvania State University system is testing another system called Web Assessor. It uses proctors, Web cameras, and software that recognize students' typing styles, such as their speed and whether they pause between certain letters. Students purchase the cameras for \$50 to \$80 apiece. They allow proctors to view a student's face, keyboard, and workspace.
 - **The Phoenix-based provider of the system, Kryterion Inc.,** employs proctors who remotely observe and listen to as many as fifty (50) testees at a time. In China, video cameras are installed in almost 60,000 test centers around the country to prevent testees cheating in the national college entrance examination.
8. **Cheat-resistant laptops.** The University of Central Florida (UCF) and Norway students take their tests on cheat-resistant computers that restrict access to just the exam in a super secure testing center.
9. **Computer-adaptive testing and randomized testing.** When items are randomized, candidates find it impossible to cheat or copy their colleagues. Questions are set and reordered such that they are not serialized in the same pattern with the next door candidate. Randomization of items on tests is similar to unique items being served up on a computer adaptive exam but different in that no statistical sequence is utilized to select the next item.
10. **Statistical analysis.** Some researchers and companies are beginning to introduce sophisticated statistical and mathematical models that help identify potential cheats using computer analysis to compare a candidate's exam answers with the typical behaviours of other candidates' responses. This is a technique that gives strong statistical indication of whether someone has cheated or not. Caveon uses the science of Item Response Theory (IRT) to calculate the probabilities that two people worked together or did not take the test independently.

CONCLUSION

This research highlights that 21st-century assessment digitization, alongside Innovative and Interactive Music items and advanced technological controls, are crucial for ensuring credible high-stakes examinations in Music. The study expresses concern over Nigerian testing bodies' long-standing reliance on snipped Sibelius and Finale Music scores or other notation tools, which has limited the use of more dynamic and resourceful Interactive and Innovative Music items.

The integration of ICT and the use of CBT by Nigerian high-stakes examination bodies demonstrate that this approach is both feasible and essential for sustained progress.

Introducing Interactive Music items would significantly reduce cheating, as these innovative items are not easily copied or manipulated once computerized.

Even if accessed before an examination, altering the musical scores or notes for dishonest purposes becomes nearly impossible. However, certain challenges exist, ranging from logistical to technical issues. Computer hardware, printers, modems, and routers are vulnerable to breakdowns and malfunctions, while viruses and malware could compromise performance.

To mitigate these risks, Nigerian high-stake examination bodies must have backup computers and contingency plans in case of equipment failures or server issues. Additionally, ensuring a reliable power supply, such as inverters or generators capable of running for 8–10 hours, is vital for maintaining effective operations.

RECOMMENDATIONS

Based on the above findings, the researcher makes the following recommendations:

- i. **Adoption of Innovative Music Items:** Stakeholders in high-stakes examinations should embrace the use of innovative music items instead of relying solely on Sibelius software.
- ii. **Increased ICT Utilization in Assessment:** High-stakes examination bodies should integrate ICT more fully into their assessment processes.
- iii. **Design of Test Items with Unique Applications:** Examination bodies should prioritize setting test items that require higher-order thinking and application, rather than over-reliance on simple recall questions.
- iv. **Curriculum Upgrade in Higher Education:** Nigerian higher institutions, particularly Music Departments, should update their teaching curricula to incorporate technology and modern tools like Sibelius, MuseScore, Finale etc.
- v. **Integration of Notation Software in Secondary Schools:** The national curriculum should be revised to include instruction on Music notation software such as Sibelius, MuseScore, and Finale, ensuring that secondary school students are equipped with these skills before entering higher education.
- vi. **Training and Re-training of Music Personnel:** Investment is needed in training and retraining staff in the Music Units or Divisions of Nigerian testing bodies. Personnel in the Test Development or Examination Development Departments should enhance their expertise in animation, audio, and digital programming.
- vii. **Upgrading Music Technology in Examination Syllabuses:** Music Technology in the syllabuses of Nigerian high-stakes examination bodies should be expanded to include elements like animation, audio and video programming, and graphic design.
- viii. **Teacher Education Curriculum Adaptation:** The teacher-education curriculum must be updated to reflect the evolving technological advancements of the 21st century.

REFERENCES

- Adesipe, E.A. and Otunla, A.O. (2016). *Joint Admissions and Matriculation Board – Computer-Based Test: Pioneering Innovative Admissions and Placement Examinations in Nigeria*. A Book of Readings in honour of Emeritus Prof. Dibu Ojerinde, OON on Public Examining in Sub Saharan Africa: Issues, Challenges and Prospects. Vol. 1, pp. 97-107. Published by JAMB, Nigeria. Marvelous Mike Press Ltd. Garki Abuja, Nigeria (2016).
- Adesipe, E.A. (2017). *Utilisation of Information and Communication Technology in Assessment Through The Use of Computer-Based Test*. A Book of Readings in Honour of Emeritus Prof. (Rt.Rev.) Evans Jonathan Ibeagha. Vol.1, Pp 131 – 146. Published by Nike Diocesan Printing Press 3, Emelugo Drive, Hill View Trans Ekulu, Enugu State Nigeria (2017).
- Adeyanju L.J (2006) Teacher Quality, Modern Technology, Applications and Teaching in a South-Western Nigerian University. *Journal on School Educational Technology. Vol.2. No.4 pp.31-36*
- Adeyanju O. J. (2015). Emerging Trends in Innovative and Dynamic Education and Examining Educational Technology Role in Nigerian Higher Institutions. Lead paper presented at the 17th

- Annual National Conference of the Association of Educational Researchers and Evaluators of Nigeria. University of Ibadan; 12th -17th July, 2015.
- Anikweze, C.M. (2012). Measurement and Evaluation for Teacher Education, 3rd edition, Ibadan: Constellation Publishers Ltd.
- Black, P. and William D. (1998). Assessment and Classroom Learning; Assessment in Education: Principles, Policy and Practice March 1998 pp. 7-68.
- Egberongbe A.A. (2012). Generating Test Items For Computer-Based Testing (CBT). An unpublished paper presented at the in-house item Seminar/Workshop at the complex of the Test Development Department of JAMB, National Headquarters, Bwari FCT Abuja on 29th November, 2012.
- Huff, K.L. and Sireci, S.G. (2001). Validity Issues in computer-based testing. *Educational Measurement: Issues and practice* 20 (3), 16-25.
- JAMBNews, (2013). The Dutch Examination Body CITO, CBT Experience: A Lesson for Jamb. JAMB's Quarterly Publication Magazine Published by JAMB Vol. 4, Nos.23; January to March
- JAMBNews, (April 2013). Reliability And Validity As Tools For High Quality Assessments. JAMB's Quarterly Publication Magazine Published by JAMB Vol. 4, Nos.24; April - June
- JAMBNews, (2013). CBT: So Far, So Good. JAMB's Quarterly Publication Magazine Published by JAMB Vol. 4, Nos.25; July - September
- Kane, M.T. (1992). The Assessment Of Professional Competence. *Evaluation and the Health Professions*, 15, 163-182.
- Obioma, G.O. (1998). *Statistics For Educational Measurement*. Owerri Wisdom Publishers Ltd.
- Parshall, Davey and Pashley (2000). Innovative item types for computerized testing. In W.J. van der Linden and C.A.W. Glas (eds.). *Computerized Adaptive Testing: Theory and Practice*. Netherlands: Kluwer Academic Publishers.
- Scalise, K. and Gifford, B. (2006). Computer-based assessment in E-learning: A framework for constructing "immediate constraint" questions and tasks for technology platforms. *The Journal of Technology, Learning and Assessment* 4 (6). Retrieved on 5/10/2007 from <http://www.jtla.org>
- The Web; 1999. University of Education, Winneba Ghana. *University Registry*.
- Zenisky, A. L., & Sireci, S. G. (2002). Technological innovations in large-scale assessment. *Applied Measurement in Education*, 15(4), 337-362.