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Perceived Effectiveness of Computer–Based Assessment among Engineering Students in Nigerian Universities

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ABSTRACT
The Computer-Based Assessment (CBA) approach is a popular method to evaluate students' performance at the tertiary institution level. Despite the varieties of computer-based assessments employed today, there exist biased views, and questions have been raised on its effectiveness in assessing knowledge of some engineering courses. Therefore, the goal of this research is to investigate engineering students' perceptions about computer based assessment in various Universities in Nigeria, with the aim to determine its effectiveness in assessing knowledge of some courses. In order to achieve this aim, survey questionnaires were designed as research instrument and administered randomly to engineering students from 30 selected Nigerian Universities in all the six geopolitical zones of the federation, who have in one way or the other been assessed via computer based approach. A total of 329 responses were received, and analyzed. Findings showed that engineering students unsatisfied with computer based approach for examinations; students' responses indicated that the drawbacks outweighed the benefits. Majority of the students expressed their overwhelming preference for the paper-based assessment due to the problems associated with computer- based assessment. This study recommends that University administrators consider paper-based assessment for engineering students and improve the computer interface of systems to accommodate multiple-choice tests, short answers, and essays.

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INTRODUCTION

Assessment is a way of testing the ability of students; it is an important factor that reflects and affects the quality of learning and education. Assessment is high quality information about students' performance that informs teaching and learning (National Research Council, 2003). It is a yardstick to test their knowledge and innovative competence. By the nature of engineering programs, students are assessed through laboratory practical, tutorials, continuous assessments and examinations, the examination which often covers 60 percent to 70 percent of the overall assessment. Irrespective of the assessment type, there are two major modes of assessment viz; Traditional Method of Assessment (Paper-based) and Computer-based Test (CBT). Today, there exists a higher prevalence of computer-based assessment in Universities, leading to the improvement over the traditional method of assessment. The rapid adoption can be associated with the numerous advantages which Universities derive from Computer-based approach over the traditional method. As highlighted by Samy and Mostafa (2018), several advantages provided by the Computer-based assessment range from proposing a solution to mechanize the assessment process (Triantafillou *et al.,*2008); reducing paper consumption which indirectly reduces greenhouse gases and energy consumption (De Rosa 2007); assisting students to evaluate their strengths and weaknesses (Kaklauskas *et al.,* 2010); and providing quantitative improvements in assessment for

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academics and tutors (Singleton 1997). These improvements can be noticed in reducing preparation time and cost, enhancing the test security, analyzing the results easily, keeping record for item analysis and reliability of scoring Gvozdenko and Chambers (2007); Sanni and Mohammad (2015); (Singleton, *et al*., 1999) Smith and Caputi (2005); Tippins (2011), increasing efficiency (Halcomb *et al*., 1989); (Karay *et al*., 2015); Lee and Barua, (1999); Zakrzewski and Bull (1998), and providing instantaneous feedback to students Bugbee (1996); Bull and McKenna (2003); Butler (2003); (Erturk, *et al*., 2004); Zandvliet and Farragher (1997). Moreover, the Computer-based test offers enormous scope for innovations in testing and assessment Bennett (1998); Chatzopoulou and Economides (2010) and measures complex form of knowledge and reasoning which is not possible through traditional methods Bodmann and Robinson (2004). Students find the use of Computer-based approach more promising, credible, objective, fair, interesting, fun, fast and less difficult or stressful (Croft *et al.,*2001); (Sambell *et al*.,1999). Computer-based testing assessment also reduces the burden of academic and non-academic staff in conducting examinations purposefully, especially General Studies Examination (GSE). Moreover, it reduces the required efforts and times for exams generation, scheduling, marking, and results recording and analyzing Ko and Cheng (2008), allowing room for automated grading, ease of distribution, automatic record keeping for item analysis and distance learning, especially when evaluating large groups of students. Furthermore, it allows authentic assessments due to more advanced technological capacities (Cantillon *et al.*, 2004); (Csapo *et al.,* 2012). Computer-based approach has been implemented to support various technologies, educational environments, and cultures.

However, there are drawbacks when administering computer based test, such as looking at the computer screen for a long time, and anxiety from changing the exam mode from paper based test to computer based test Butler (2003), additional need for adequate facilities, more test-security, back-up procedures in case of technological failure, and time for staff and students to get acquainted new technology (Cantillon *et al*.,2004). Mubashrah (2012) identified two major administrative reasons for students' negative attitude towards computer-based assessment. Firstly: problems of load shedding (that is, breakage in power supply) and secondly: lack of technical staff and insufficient number of computer systems in computer laboratories.

Due to these major reasons, students were losing their confidence in online systems of examinations and believed that 'technology is not reliable'. In these situations, students preferred to take paper-based examinations and tests. The comprehensive implementation of Computer-based test mode has also been hindered by questions such as the equivalence of Computer-based test mode to Paper-based test mode Akdemir and Oguz (2008); Chua and Don (2013). Lee and Weerakoon (2001) and Russel (1999) both reported enhanced student performance on paper over computer while Clariana and Wallace (2002) reported enhanced performance on computer over paper. Others continue to report no difference Ozalp-Yaman and Cagiltay (2010); (Ashton, *et al.,* 2005). (Meagan *et al*., 2014) researched on the effects of computer versus paper-based test mediums, and found out that they are conflicting and do not always find a favorable result for computer-based test.

Currently in Nigeria, there exist large number and varieties of computer-based assessments. Most Computer-based assessments in Nigerian Universities are based on objective questions, which are multiple choice items, and this assessment, have been found to only test low level learning outcomes. According to Buma and Miryam (2004), when teaching large numbers of students, lecturers are often forced to use multiple choice exams because they provide objective grading. On the other hand, multiple choice tests have many disadvantages, such as; difficulties in setting theoretical questions, and their understanding of the proofs. Mubashrah (2012) stated that frequent use of multiple-choice items can lead to a focus on testing a superficial level of understanding. Findings by Mike (2000) have also shown that computers cannot be used for all assessments because some educational outcomes, particularly those with a creative component, are too difficult to measure with the defined rule that a computer program needs. Meanwhile, most Universities have adopted Computer-based assessments to assess

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students in various tests and examinations. There has also been controversial interest among various researchers on which assessment mode is now justifiable in actual test of engineering knowledge. Therefore, the need to ascertain the effectiveness of Computer-based assessment in testing learning outcomes of engineering courses cannot be over emphasized. The research aims at examining the effectiveness of Computer-based assessments in assessing knowledge among University engineering students in the six geopolitical zones of Nigerian.

Research objectives

The research objectives of this study are to:

1. understand the perception of engineering students about Computer-based assessment,
2. investigate the reasons behind students' preference for Computer-based test or paper based assessment in some engineering courses,
3. ascertain whether Computer-based assessment actually test engineering knowledge outcomes,
4. itemize some engineering courses, whose knowledge might not be assessed via computer based assessment approach.

Research Questions

The research questions addressed are:

1. What are the perceptions of engineering students about Computer-based assessment?
2. What are the reasons behind students' preference for Computer-based assessment or Paper based assessment in some engineering courses?
3. Does Computer-based assessment actually tests engineering knowledge outcomes?
4. What are the engineering courses whose knowledge should not be assessed via CBA?

LITERATURE REVIEW

Computer Based Assessment (CBA).

The Computer-based assessment first emerged in educational settings in the 1950s and has undergone a steady expansion in use Matt (2010). It is used in various ways as an integral part of many currently used Computer Aided Learning environments Thelwall (2000). In the early days, Computer-based assessment was restricted to text-based simple question and answer sessions written by programmers. Later, authoring systems were developed to create more user-friendly products and wider access for academics Whiting (1985). Today, questions do not now have to be text-based but can also incorporate graphics and multimedia. Responses assessed can include multiple choice selections, graphical hotspot clicking, text, numerical, mathematical answers and many more. Computer-based assessment is now used for exams, mid-unit tests and diagnostic assessments. It is also found as an integral part of many Computer Assisted Learning packages. One strand running through a number of computer-based assessment projects has been the ability of the software to randomly generate questions for the students or to randomly select a coherent subset of questions from a large question bank. This has been achieved in a variety of different ways, particularly in mathematics and the sciences, and has served different purposes. Informative assessments random tests can provide large sets of questions for students to practice, with instant feedback Thelwall (2000). Computer Based Assessment systems are implemented using Information and Communication Technology (ICT) tools and applications, Terzis and Economides (2011). Computer-based assessment is considered as a very important tool to evaluate students at specific point and to help learners in identifying the gap between required standard and actual level of the learners (Deutsch *et al*., 2012). Currently, Computer-based assessment is being a main part of electronic learning and assessment systems in higher education institutions. It is being adopted by many institutions replacing the traditional paper and pen assessment for students, Sieber and Young (2008). Computer based assessment technologies have been proposed as a solution to mechanise the assessment process Charman and Elmes (1998); Chatzopoulou and Economides (2010); Economides and Roupas (2007); (Triantafillou, *et al.,* 2008).

Traditional Assessment

Traditional assessment refers to the conventional methods of testing which usually

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produces written document, such as quizzes or exams. Standardized test, most state achievement test such as Basic Education Certification Examination (BECE) and West African Senior School Certificate Examination (WASSCE) are also examples of traditional assessment Frank (2018). These comprise tests given to students by teachers to measure how much the students have learned. The most widely used traditional assessment tools include multiple-choice tests, true/false tests, short answers, and essays. Multiple choice tests are commonly utilized by teachers, schools, and assessment organizations because they are economical, objective and easily scored Bailey (1998). True/false items require students to make a decision and find out which of two potential responses is true. They are easy to score and administer. However, guessing might increase the chance of success by 50% (Simonson *et al*., 2000). In short-answer test, items are written either as a direct question requiring the learner to fill in a word or phrase or as statements in which a space has been left blank for a brief written answer (Simonson *et al.,* 2000). Lastly, essays are effective assessment tools since the questions are flexible and assess the higher order learning skills. However, they are not very practical due to the fact that it is very difficult and time consuming to score the essays. Moreover, subjectivity might be an issue in scoring (Simonson et al., 2000).

Replacement of Paper Based Test with Computer Based Test

Globally, Universities are increasingly adopting computer-based testing (CBT) to replace the traditional paper and pen testing for academic assessment of students Sieber and Young (2008). (Siozos *et al.,* 2009) noted that the Paper Based Assessment is being disassociated gradually from learning practices because of continuous dissemination of Information and Communications Technology (ICT). At the same time, Computer Based Assessment is being replacing the Paper Based Assessment, due to the popularity of ICT. As part of e-learning trend, the computer-based tests (CBT) became more prevalent than paper-based tests (PBT) in the domain of educational assessment as changes are made in assessment methodologies reflect practical changes in pedagogical methods Organization for Economic Co-operation (OECD) (2010). Terzis and Economides (2011) reported that students prefer computer-based assessment instead of Paper Based Assessment, as they believe that it would be exciting, interactive, secure, precise, smooth and credible. Currently, computer-based examinations are utilized in university setting as well as in other areas such as government-related examinations and standardized testing. Additionally, computer-based exams are increasingly common in the university setting along with the increasing prevalence of online textbooks, course content databases, and homework or other online assessments.

RESEARCH METHODOLOGY

The research methodology was a quantitative approach where a structured questionnaire was used as the research instrument. The questions were measured using a dichotomous scale of 'YES' and 'NO', Likert-type scale from 1 to 4 (with response options as follows: Strongly Agree(4), Agree (3), Strongly Disagree (2), Disagree(1)) and short answer questions. The randomly selected samples for this study were 300 level to 500 level engineering undergraduate students from thirty (30) Nigerian universities in the six (6) geopolitical zones, who had previously been assessed via computer based examination (Table 1). It was believed that at 300 level, these students, from various departments (Table 2) must have offered courses that are related to their engineering professions, the knowledge of which can be assessed. The overall sample size for this study was 329 students.

Table 1: Selected Institutions in the Geopolitical zones

Institution	Geopolitical zone
Abubakar Tafawa Balewa University, Bauchi	North East
Adeleke University, Ede.	South West
Ahmadu Bello University Zaria	North West

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Ajayi Crowther University, Oyo	South West
Ambrose Alli University, Ekpoma	South South
Ekiti State University, Ado-Ekiti	South West
Enugu State University of Science and Technology, Enugu	South East
Federal University of Agriculture Abeokuta	South West
Federal University of Agriculture Makurdi	North Central
Federal University of Technology Akure	South West
Federal University of Technology Minna	North Central
Federal University of Technology, Owerri.	South East
Federal University Oye-Ekiti	South West
Joseph Sarwuan Tarkaa University Makurdi	North Central
Kebbi state University of Science and Technology, Aliero	North West
Kwara State University	North Central
Lautech, Ogbomoso	South West
Nigerian Defence Academy, Kaduna	North West
Nnamdi Azikiwe University, Awka	South East
Obafemi Awolowo University, Ife	South West
Olabisi Onabanjo University, Ago-Iwoye	South West
Osun State University	South West
University of Benin	South South
University of Ibadan	South West
University of Ilorin	North Central
University of Jos	North Central
University of Lagos	South West
University of Maiduguri	North East
University of Nigeria Nsukka	South East
University of Uyo	South South
Total Universities	**30**

Table 2: The various Engineering Departments

Agricultural and Bio-systems Engineering
Agricultural and Environmental Engineering
Agriculture and Bio-resources Engineering
Biomedical Engineering
Building Engineering
Chemical Engineering
Civil Engineering
Civil and Environmental Engineering
Civil and water resources Engineering
Computer Engineering
Computer Science and Engineering
Electrical and electronics Engineering

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Industrial and Production Engineering
Materials Science and Engineering
Mechanical Engineering
Mining Engineering
Production Engineering
Structural Engineering
Telecommunications Engineering
Water Resources Management engineering

RESULTS AND DISCUSSION

Population of respondents

Male engineering students represented 87.2%, while female accounted for 12.8% (Figure 1). This shows that more male students study engineering than female students in Nigeria, and both sexes expressed their views on the effectiveness of computer-based assessment in Nigerian universities.

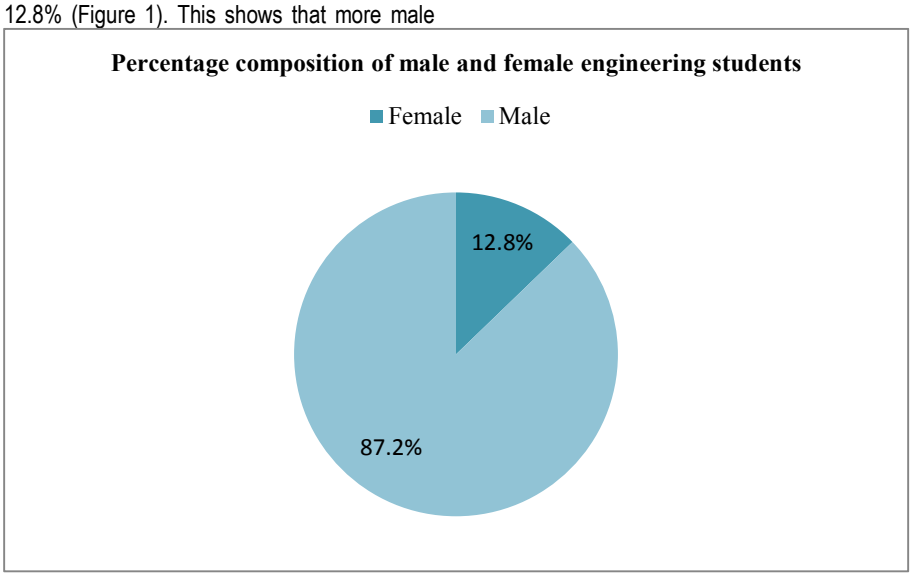

Figure 1: Percentage composition of male and female engineering students

Perceptions of Engineering Students about Computer Based Assessment

From the results, 73.7% agreed that Computer Based Assessment (CBA) approach is being a very popular method to evaluate students' performance at the university level. This agrees with (Meagan *et al*.,2014), who reported that secondary and higher education are evaluating students' performance and achievement using Computer-based approach very intensively. Response from the survey also revealed that it has been utilized to assess the students in courses like Applied mechanics, strength of materials, workshop machine programming, soil mechanics, structural analysis, AUTOCAD, engineering drawing, computer aided design and structural drawings and calculation, engineering thermodynamics and other related engineering courses such as ARCGIS.

Reasons behind Students' Preference for Paper Based Assessment in Some Engineering Course.

From the response, 50.3% feels they are more comfortable taking paper pencil based test, whereas 49.7% prefer CBT. Similarly, 55.7% of the respondents noted that CBT is easy to pass and helps to build their CGPA. In the same vein, 55.2% reported from their experiences some observations in the administration of CBT, some of which are;

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Brevity of time allotted

Psychologically, some students are slow learners, while others are not. Slow thinkers, need more room to think through before answering the questions, and may not able to meet up with the allotted time, hence they automatically get logged out. It was reported that courses involving calculations require much time, and time allotted for CBT is grossly inadequate.

Inadequate ICT Facility

It was reported that some ICT halls are small and cannot accommodate all the students at once. Some computers were reported not functional and not effective at times, noting that some would have developed fault before the examination day, and not attended to, once the students login to such computers, they start malfunctioning.

Network issues

Assessments conducted online have been reported hassled, because the servers cannot handle a lot of users at the same time. Poor internet or server network connection is a problem in administering CBA in most universities as it wastes the students' time. This is traceable to the limited available bandwidth allotted for the CBA. Sometimes, while students are still writing their examination, the server might stop responding, thereby requiring the student to login again and restart the examination. Sometimes, the computer logs out the user automatically when the student is yet to submit.

System and power supply

Inadequate power supply was also identified as a problem in administering CBT in Nigerian Universities. It was reported that sometimes electric power goes off during the CBT examination, while relying on uninterrupted power supply (UPS) which are not often in good working condition, before switching to generator. The examination stops when there is power interruption, and often requires the students to start all over again. This creates fear, anxiety when taking computer based tests and pressure to finish up before any power failure occurs. Some students reported that they find it difficult to get their result after the examination.

Question management

Cases were reported where wrong computer based exam questions were uploaded, some questions were incomplete while some were not having correct answers. Answers in JPEG format were reported not displayed, some formula were also not written the right way, some questions were also repeated.

Expression of thoughts

Expression aids learning faster. It was also reported that CBT does not allow students express how well they understand, restricting them to the pick answers provided on the screen.

Question setting

Almost all engineering courses taught are usually based on derivations, proofs, theories and practical, and each correct logical step is marked. Designs involve calculations, and the students need to understand design from first principles, meanwhile, in CBT, the student might fail for clicking the wrong answer possibly by mistake, while the steps are correct. It was noted that there are certain aspects of engineering knowledge that cannot be tested effectively assessed with administration of CBT especially when it requires showing of solutions, proofs or diagrams, this sets a limit to the quality of questions which the lecturer might set. These questions are often on the periphery and are not deep enough to assess knowledge. It was reported that CBT can only show right or wrong answers to the lecturer but and cannot show the lecturer how close a student was to the right answer. CBT is to the students' advantage because it weakens the standard of engineering questions.

Guess work

It was reported that CBT only shows who got an answer right and who got it wrong, regardless of who guessed the answer from the options and who actually worked it out, making it inadequate to test the student's knowledge of the course. Students were reported to do more guesswork approach to solution. Some were reported to be good at guessing and most times end up choosing the right answer. (Simonson *et al.,* 2000) asserts that guessing might increase the chance of success by 50%. Because of the random selection for questions, some students

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may be lucky to have the simple ones while others get the hard ones.

Engineering Courses Whose Knowledge Should Not Be Assessed Via CBA

Finding showed that 74.3% suggested that some engineering courses should not be based on CBT, but paper-based, such as; engineering drawing, practical-based courses, engineering mathematics, theory of structures, design and analysis of structures, engineering mechanics, fluid mechanics, thermodynamics, programming courses, hydrology and hydraulics, strength of materials, structural analysis, soil mechanics, foundation engineering, engineering statistics, structural vibration analysis, design of plates and shells, workshop practical, design studio etc. Courses which are more of literature are preferred to be assessed via CBT, these include such as engineer in society, engineering law, introduction to entrepreneur education, introduction to engineering practice, engineering economics. etc. Li (1999) reported that computer-based test has a trend to weak some traditional academic skills, which is still very useful in current time. For example, reading of drawings are the basic and most common skills required of an engineer, they need to improve these skills by practice. Too much Computer-based test in engineering will "give" trainee too many "easier work" in machinery structure reading.

Use of computer to model

Modeling and designing, analysis of engineering components can be done using various software. It was reported that it is possible an engineering student have a good mastery of computer software to model, design or run an analysis and yet be devoid of basic practical knowledge. Being able to run the software successfully and interpret the results requires skills and full understanding of both the manual approach and the programming involved. Perhaps there is a mistake in the analysis, it can be easily corrected.

CBT and Exam malpractices

81.7% believe that CBA reduces examination malpractices, on the other hand, 19.8% still believe that CBA can be manipulated, and it is the easiest way for students to communicate and cheat, noting that there are student hackers, who can even get the answers before coming into the examination hall, making it easy for them to share answers with their friends before the examination. Subtly, students use phone in the hall, search the questions on the internet, whisper answers to their mates in the CBT cubicle. Also, CBAs are often done in batches, this makes some questions from the previous batch to be divulged to the ones yet to take theirs. Similarly, not all systems display the picture of individual student taking examination, this gives some students the chance to answer questions for their friends. Most systems require the matric number as login detail and password, making it possible for any student to write any exam for another. Negligence and carelessness of the invigilators give students advantage to cheat, since only short answers are required. This develops laziness and unwillingness to have indebt study among students.

CBA in assesses engineering knowledge outcomes

From this research, 72.2% of the respondents believed that CBA is not adequate in testing the knowledge of most engineering courses, because it limits the extent to which the student can express his knowledge of the subject matter, thereby providing a shallow knowledge of the course. It was also noted that CBT can be passed or failed without proper knowledge of the course. Each logical step is marked in paper based test, whereas only the final answer is marked in CBT, making it not holistic in assessing knowledge. The students tend to study on the surface level rather than in-depth study simply because there is always an option to pick. Likewise, 81.1% agreed that it possible for a student to pass a course via CBT and yet not having the full understanding of the knowledge of it. Finally, 66.3% indicated that computer based assessment is not appropriate for testing knowledge of engineering professional practice.

CONCLUSION

The study reveals the perceptions of engineering students about the computer-based assessment in Nigerian Universities. From findings, assessing engineering students' knowledge via computer based approach has not been satisfactory, as responses have shown that the drawbacks outweigh the benefits.

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Besides, high level of engineering education has been maintained and sustained by universities before the era of computer-based technologies, however, technological problems made this system of examination unreliable. Majority of the students indicated their overwhelming preference for the paper-based assessment due to the problems associated with computer- based assessment. Some of the problems highlighted include; brevity of time allotted, poor ICT facilities, network issues, poor system and power supply, question management, inability of students to expression thoughts, examination malpractices and so on. Courses that involve calculations and proofing, designs and analysis etc. are preferred to be paper based. Majority of the students indicated that computer based assessment is not appropriate for testing knowledge of engineering practice, and courses like engineering drawing, practical-based courses, engineering mathematics, theory of structures, design and analysis of structures, engineering mechanics, fluid mechanics, thermodynamics etc., are preferred to be assessed via paper based approach. This study contributes to knowledge and fills evident gap in literature by carefully exposing the minds of engineering students on problems associated with the computer-based assessment which is the mode of assessment most universities uses, so that university administrators can consider paper based assessment for engineering students where appropriate and improvement of computer interface for computer based to accommodate multiple-choice tests, short answers, and essays. If administrators of universities are interested to apply CBA properly, then it will be important to take preliminary steps to control the highlighted problems. The overall effect result in development of skilled, competent, and knowledgeable engineering graduates, who will be innovators for change and future development of Nigeria. The presence of ICT is not meant to abolish the process but to be a value-added approach.

RECOMMENDATION

Based on these findings, the following recommendations are hereby made;

1. There should be less reliance on CBT multiple choice questions for evaluations and assessments, so that students can express ideas and not be limited to options provided on the screen. By this, learning outcomes can be well assessed.
2. Instead of CBT multiple choice questions adopted for assessment in most Nigerian universities, examinations should be based much on practical classes in order to improve students' creativity and understanding of some concepts.
3. Courses that involve calculations and proving of formula, should be paper based

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