GENDER DIFFERENCES OF SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY USING COMPUTER-BASED TEST AND PAPER-BASED TEST

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Abstract
The study examined senior secondarystudents' academic achievementand gender differences in Biology using computer-based test (CBT) and paper-based test (PBT) in Jalingo Education Zone, Taraba State, Nigeria. Three research questions were raised and three null hypotheses were tested at .05 level of significance. The study adopted the ex post facto research design. The population of the study comprised senior secondary school II (SSII) students across Jalingo education zone in Taraba State. The Sample for the study consisted of 341 students (CBT group: Male, 79 & Female, 85 and PBT group: Male, 88& Female, 89). This was drawn though purposivesampling.Theinstruments used for data collection included the Biology Achievement Computer-Based Test (BACBT) and Biology Achievement Paper-Based Test (BAPBT). Mean and standard deviation were used to answer research questions while the independent samples t-test was used to test the hypotheses. Results of the comparative analysis of students performance in Biology in CBTand PBT groups revealed statistically significant difference with higher achievement in favour of the CBT group. Results in both CBT and PBT achievements among male and female students also showed no significant difference. Based on these results, the study recommends that Biology teachers within the Zone should organize teacher made CBT in their continuous assessments in classrooms that is gender-friendly to enable the students have the opportunity of familiarizing with the process and be more ICT compliant, thereby reducing their level of anxiety.

Keywords: Academic achievement, Computer-based test (CBT), Paper-based test(PBT), Biology

Introduction

Computers have a critical role in our lives and developments in computer technologies have influenced many areas including educational settings such as online learning and testing. This is evident in an increased number of computer-delivered test in educational testing due to its perceived advantages (Toroujeni, 2016). With the appearance of new technologies, computerized testing has begun to be widespread and implemented in large scale testing. Many computer-based researchers have pointed out many benefits of computer aided assessment in helping students perform better and believed that traditional measurement implementation place too much emphasis on passing a test rather than on

encouraging learners to learn beyond education. Nevertheless, as institutions started to accomplish CBT in their examination systems, concerns arise about the comparability of scores from the two administration modes with consideration to students' special characteristics (Hosseini, &Toroujeni, 2017;Khoshsima, Hosseini &Toroujen, 2017).

In Nigeria, employers now conduct aptitude test for job seekers with the use of computers which is commonly referred to as computer-based test (CBT); the universities and other tertiary institutions are registering and conducting electronic examination for their students through the internet and other electronic and networking gadgets. Similarly, different examination bodies in the country such as West Africa Examination Council (WAEC), National Examinations Council (NECO), National Business and Technical Examination Board (NABTEB), and National Teachers' Institute (NTI), among others register their students through electronic means (Olawale &Shafii, 2010). It is becoming common to see institutions across the educational strata adopt CBT to admit or screen students for entrance into Nigeria Institutions (Sadiq &Onianwa, 2011). However, this mode of conducting examination is a new phenomenon in Nigeria and not as popular as the Paper-Based Test (PBT). The use of CBT for entrance examination in education, military training, and certification examination by professional groups and promotional examination in various stages and categories of life cannot be overemphasized. Olumorin, Fakomogbon, Fasasi, Olawale, and Olafare (2013) noted that CBT has gained popularity as a means of testing with large-scale professional examination such as United State Medical Licensing Examination. However, the popularity emerged through the post UTME (Unified Tertiary Matriculation Examination) and university main examination in Nigeria.

Mojarrad, Hemmati, Gohar and Sadeghi (2013) stated that computers offer test developers the opportunity to improve their productivity and lead to innovation in their fields no matter what the test' population size is. This is usually made possible through the use of CBT. CBT helps test developers to set the same test conditions for all participants. It also improves all aspects of test security by storing questions and responses in encrypted databases and enables testers to create randomized questions and answers from vast question pools. Moreover, offering different test formats and the immediate presentation of different types of feedback, either to students or testers, are also some of the great advantages of CBT.

In the early years of CBT many basic design issues baffled test experts as they sought to transfer paper and pencil test onto a computer-based platform. In those early years, the most familiar design is where candidates fill in their responses on a paper form, which is fed into a computer optical mark reader. This reads the form, scores the paper, and may even report on the test reliability. The second design is where computers provide an assessment interface for students: they input their answers and receive feedback via a computer (Thurlow, Lazarus, Albus & Hodgson, 2010).

CBT is a critical at all levels of educational testing and the issue of comparability is considered very important for test developers and curriculum designers when deciding to substitute CBT for PBT or include it in their programs. Although CBT has advantages over PBT, analysis of the two test modes should be ensured first (Toroujeni, 2016). Literature on the comparability studies on CBT and PBT also showed different results and opposite findings. In some of these studies,

the test scores of two test were similar (Adeniji&Ubulum 2016; Alakyleh, 2018). Some other, in contrast, found different results with the priority of CBT over PBT and vice versa. For example, while results showed higher scores in CBT in Oduntan, Ojuawo, and Oduntan (2015). Contradictory findings reported lower performance on CBT than PBT (Hosseini, Abidin, Kamarzarrin & Khaledian, 2013; Khoshsima&Toroujeni, 2017).

When comparing CBT and PBT, concerns exist in regard to subgroups taking the test. The American Association of University Women as cited in Osalusi and Oluwagbohunmi (2014) found that males viewed computers as primarily masculine tools, had stronger computer skills, had more positive feelings about computers while many girls in elementary schools are less confident than boys. Ikolo and Okiy (2012) suggests that as result of gender roles assigned by different cultures, many women have been brought up to see technology and its use as reserved for on the male gender. This situation has led to what scholars have termed the gender digital divide. Explaining this, Ikolo (2010) stated that the gender digital divide is manifested in the low number of female users. It observed evidences that point towards gender imbalance in the use of computers and other technologies and furthered that the issue of gender equity as far as access to and use of ICTs continues to be a topical subject not only in developing countries but the world over. Women and girls as asserted by Kravets (2011), suffered systematic disadvantage and discrimination and this is prevalent in so-called poorest states and sectors of the Nigerian society.

Over the years, results from various research works have been inconsistent regarding the performance of test takers in relation to the test delivery mode and the interaction between the assessment modes and test taker variables. Some reported enhanced students' academic achievement in PBT over CBT while others reported achievement in CBT over PBT. Bunderson, Inouye and Olsen (2009) highlighted 23 studies that evaluated test mode effect and reported 9 studies that favored PBT, 3 studies that favored CBT, and 11 studies that reported no difference between test modes. There have also been studies that have focused on the comparability of PBT and CBT in some areas such as psychology, mathematics and ergonomics. However, there is little or no localized research in biology needed to detect any potential effect of the test delivery mode on student's academic achievement before converting conventional paper-based testing to computer-based testing. These conflicting positions and gap provide the justification for this study. Similarly, in recent years, there has been an increasing interest and tacit support by the government on developing and using computer-based test in educational assessment. The Joint Admission and Matriculation Board (JAMB) introduced a full scale CBT in the 2015 Unified Tertiary Matriculation Examination (UTME) to eliminate examination malpractice and to facilitate prompt release of results (Onyibe, Nwachi-Ikpor& Abdulhakim, 2015). Also, Examination bodies such as West African Examinations Council (WAEC) and National Examinations Council (NECO) are planning to introduce CBT in all objective papers of their examinations (Ugwuanyi, 2015).

In the same vein, Sanda and Kurfi (2013) state that in Nigeria, gender differences in ICT use are linked to patterns of discrimination in the society at large as well as with patterns of power relations within the home and that only 10 percent of the people riding the information superhighway via the internet are women. It advanced that this is the twenty-first century, yet tradition, culture,

religion and other factors have continued to widen the disparity between Nigerian men and women at the expense of women and further explains that women's marginalization from ICT stems from the assumption that women benefit less from new educational and employment opportunities and that gender differences also exist with regard to access to information, access to ICTs, developing skills to search for information, and the very use of these technologies. Notwithstanding, in recent years there are some changes in women's use of the ICTs and are now developing skills needed to operate this new technology effectively. For instance, Ozalp-Yaman and Cagiltay (2010), evaluated students' performance on different test modes on 209 first year engineering students in chemistry course with regard to gender subgroup. It concluded that females performed better on CBT. In other studies, results revealed that score comparability of male participants was higher than those of the female participants (Khoshsima et al., 2017; Garas & Hassan, 2018). However, Hensley (2015) and Alakyleh (2018) both reported no significant gender difference.Thus, the purpose of this study is to find the difference between male and female students' biology mean achievement scores in computer-based test (CBT) and paper-based test (PBT) in senior secondary schools in Jalingo Education Zone, Taraba State, Nigeria.

The study was guided by the following research questions:

i. What is the difference between students' biology mean achievement scores in CBT and PBT in senior secondary schools?

ii. What is the difference between CBT mean achievement scores in biology among male and female students in senior secondary schools?

iii. What is the difference between PBT mean achievement scores in biology among male and female students in senior secondary schools?

To also guide the study, the following null hypotheses were tested at 0.05 level of significance.

$H0_1$: There is no significant difference between students' biology mean achievement scores in CBT and PBT in senior secondary schools.

$H0_2$: There is no significant difference between CBT mean achievement scores in biology among male and female students in senior secondary schools.

$H0_3$: There is no significant difference between PBT mean achievement scores in biology among male and female students in senior secondary schools.

Methodology

This study used the ex post facto research design. This is because this study is a systematic empirical inquiry in which the research procedure does not have direct control of independent variables because they are inherently not manipulated. Jalingo Education Zone of Taraba State was chosen as the study area. The population for this study comprised of all students in senior secondary school II (SS II) in senior secondary schools in Jalingo Education Zone.

The sample size for this study was 341 (CBT group: Male, 79 & Female, 85 and PBT group: Male, 88 & Female, 89) of 2017/2018 academic session. These students were drawn from four senior secondary schools in two Local Government Areas (Ardo-kola and Jalingo) of Jalingo Education Zone. Purposive sampling technique was used. This was used because the research used typical students from co-educational schools that have covered the content areas

used in developing the instruments. Two intact senior secondary school (SS II) classes, in each school with similar characteristics were used with one class as the CBT class and the other, as the PBT class. The SSS II students were used because they constitute the group with relatively higher computer proficiency and which were not distracted by the Senior Secondary Certificate Examination (SSCE) or other standardized examinations within which period this study was carried out.

The instruments for data collection were the Biology Achievement Computer-Based Test (BACBT) and Biology Achievement Paper-Based Test (BAPBT). A 40 itemed objective test with four alternatives (a key and three distractors in each) from which students chose one correct answer (to score one mark from one correct answer and forty marks for all correct answers). The questions cover four content areas which included Plant and Animal Cell, The Endocrine System, Photosynthesis in Plants and Reproduction. This was adapted from JAMB's year 2000 - 2016 past questions and was then uploaded onto the program for the BACBT. These content areas were chosen because the students' curriculum indicated that it has been treated before the time of the research. The BACBT which was built by a CBT administrator allowed students to change answers within their test time by clicking on the new option each time they consider that necessary.

The BACBT also features an automated countdown timer, and the test was programmed to terminate automatically after 40 minutes, saving the answers recorded on the screen at the time, whether the "submit" icon was clicked or not. To be sure the students are time-conscious; the timer was prominently displayed on the computer screen. Once answers were finally submitted, students had no chance for editing. This was hosted on an offline platform and was installed into several other computers for administration. For the PBT, the BAPBT was constructed using the same questions used for the BACBT with boldly written instructions and duration and strictly supervised by the researcher and the research assistant.

In order to determine whether the instruments used in this study actually measured what it was meant to measure, effort was made to subject the instruments to scrutiny. Content validity was ensured by systematic examination of the test content to determine whether it covers the behaviour domains intended to be measured as planned in the test blueprint, which was an adapted UTME past questions.

A pilot test was carried out in a senior secondary school that was not included in the sample but with similar characteristics. This way, the timing and other testing conditions were established before administration was carried out on the subjects. The instruments which contained 53 items were administered and scored by the researcher and a computer proficient research assistant who is also a biology teacher. Twenty students were used for the pilot test with ten students for each instrument. The reliability coefficients of the instruments were estimated using the results from the pilot test. Kuder-Richardson (K-R_{20}) method of reliability estimation was used since items on the instruments were scored dichotomously (right or wrong) and have the same difficulty level to determine the internal consistency of the test (0.81 for BACBT and 0.80 for BAPBT).

The CBT group took the BACBT on a computer system and this was supervised by the research assistants and the researcher. A session of discussion and short training was held for the research assistants to ensure that they understand the study's objectives and the procedure

for taking the BACBT. The BACBT was administered for 40 minutes. The researcher set the questions, the instructions and keys, a CBT administrator built the program and uploaded the questions. The system received the commands, operated the timer and gave out results.

The BAPBT was also administered for 40 minutes using the conventional paper-based mode which required students to read from test papers provided to them and which contained clearly written instructions and test duration. Students used their pens to tick the correct answers from the alternatives provided. Cheating and all forms of malpractice during this period were ensured eliminated as the administration process was supervised by the researchers and the research assistants.

The research questions raised in this study were answered using mean, and standard deviation. The hypotheses formulated in this study were tested using independent samples t-test since two different and independently assigned groups were tested in male and female groups of the CBT, male and female groups of the PBT. These computations were done at .05 level of significance using Predictive Analysis Software.

Results

Answering Research Question 1

The answer to research question 1 is presented in Table 1.

Table 1: Mean Achievement Scores and Standard Deviations of CBT and PBT.

	Group	**Number**	**Mean**	**Standard Deviation**
Score	CBT	164	26.65	3.875
	PBT	177	23.57	4.200
Mean Difference			3.08	

Result of Table 1 shows that students' biology mean achievement scores in CBT is 26.65 with standard deviation of 3.875 while that of the PBT is 23.57 with standard deviation of 4.200. The difference between the mean achievement scores of CBT and PBT is 3.08.The standard deviation scores of the two groups indicate that scores are comparable. The CBT and PBT mean score difference show that students' scores are higher in the CBT. This suggests that students performed better in CBT than their PBT counterparts, but was tested with $H0_1$ in Table 4.

Answering Research Question 2

The answer to research question 2 is presented in Table 2.

Table 2:Mean Achievement Scores and Standard Deviations of Male and Female Students in CBT.

	Group	Number	Mean	Standard Deviation
CBT	Male	79	26.54	3.518
	Female	85	26.75	4.197
Mean Difference			.21	

Results of Table 2 shows that the mean achievement scores of male students who were tested using CBT is 26.54 with standard deviation of 3.518 while that of the female students tested using CBT is 26.75 with standard deviation of 4.197. The difference between the mean achievement scores of male and female students in CBT is .21.The standard deviation scores of the two groups indicate that scores are comparable. The male and female mean score difference shows that female students' scores are higher in the CBT. This suggests that female students performed better in CBT than their male counterparts, but was tested with $H0_2$ in Table 5.

Research Question 3

The answer to research question 3 is presented in Table 3.

Table 3:Mean Achievement Scores and Standard Deviations of Male and Female Students in PBT.

	Group	Number	Mean	Standard Deviation
PBT	Male	88	24.07	4.037
	Female	89	23.08	4.323
Mean Difference			.99	

Results of Table 3 shows that the mean achievement scores of male students who were tested using PBT is 24.07 with standard deviation of 4.037 while that of the female students tested using PBT is 23.08 with standard deviation of 4.323. The standard deviation scores of the two groups indicate that scores are comparable.The difference between the mean achievement scores of male and female students in PBT is .99. The male and female mean score difference shows that male students' scores are higher in the PBT. This suggests that male students performed better in PBT than their female counterparts, but was tested with $H0_3$ in Table 6.

Testing $H0_1$

The result of $H0_1$ tested is presented in Table 4.

Table 4: Independent Samples t-test of Significant Difference between Students' Biology Mean Achievement Scores in CBT and PBT.

	Levene's Test for Equality of Variances		**t-test for Equality of Means**			
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference
Equal variances assumed	3.202	.074	7.026	339	.000	3.082
Equal variances not assumed			7.047	338.994	.000	3.082

In Table 4, Levene's test for equality of variances was used to test whether the variance of scores in CBT and PBT is the same. The test shows that the variance is the same at .05 level of significance (p = .074). The independent samples t-test conducted to compare the achievement score shows that there is significant difference of scores in CBT (M = 26.65; SD = 3.875) and PBT (M = 23.57; SD = 4.200); t (339) = 7.026; p = .000]. The magnitude of the difference in the mean scores was medium (eta squared= t^2/ [t^2+ (N - 2)] = .127). The effect size (eta squared) shows that the test mode difference in biology achievement between CBT and PBT is 12.7%. Thus, $H0_1$ of no significant difference between students' biology mean achievement scores in CBT and PBT in senior secondary schools,was rejected.

Testing $H0_2$

The result of $H0_2$ tested is presented in Table 5.

Table 5: Independent Samples t-test of Significant Differencebetween CBT Mean Achievement Scores among Male and Female Secondary School Students.

	Levene's Test for Equality of Variances		**t-test for Equality of Means**			
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference
Equal variances assumed	2.261	.135	-.344	162	.732	.209
Equal variances not assumed			-346	160.334	.730	.209

In Table 5, Levene's test for equality of variances was used to test whether the variance of scores in CBT among male and female students is the same. The test shows that the variance is the same at .05 level of significance (p = .135). The independent samples t-test conducted to compare achievement score shows that there is no significant difference in CBT scores of male students (M = 26.54; SD = 3.518) and female students (M = 26.75; SD = 4.197); t (162) = -.344; p = .732]. The magnitude of the difference in the mean scores was small (eta squared= t^2/ [t^2+ (N - 2)] = .0007). The effect size (eta squared) shows that the difference in CBT achievement between male and female school students is .07%. Thus, $H0_2$ of no significant difference between CBT mean achievement scores in biology among male and female students in senior secondary schools, was retained.

Testing $H0_3$

The result of $H0_3$tested is presented in Table 6.

Table 6: Independent Samples t-test of SignificantDifference between PBT Mean Achievement Scores among Male and Female Secondary School Students

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference
Equal variances assumed	1.129	.289	1.574	175	.117	.990
Equal variances not assumed			1.574	174.432	.117	.990

In Table 6, Levene's test for equality of variances was used to test whether the variance of scores in PBT among male and female students is the same. The test shows that the variance is the same at .05 level of significance (p = .289). The independent samples t-test conducted to compare achievement score shows that there is no significant difference in PBT scores of male students (M = 24.07; SD = 4.037) and female students (M = 23.08; SD = 4.323); t (175) = 1.574; p = .117]. The magnitude of the difference in the mean scores was small (eta squared= t^2/ [t^2+ (N - 2)] = .013). The effect size (eta squared) shows that the difference in PBT achievement between male and female students is 1.3%. Thus, hypothesis three of no significant difference between the mean achievement scores in PBT among male and female biology students in senior secondary schools in Taraba State was upheld.

Discussion of Findings

The main independent variables in this study are the CBT and the PBT. Moderator variables is student's gender while the dependent variable is the biology students' academic achievements.The findings are discussed according to the dependent and independent variables as considered in the research questions raised and hypotheses formulated.

Table 1 and 4shows the difference between students' biology mean

achievement scores in CBT and PBT. Results indicated that students' scores are higher in the CBT. The independent samples t-test of significant difference conducted between the mean achievement scores in CBT and PBT indicated a statistically significant difference between students' biology mean achievement scores in CBT and PBT in senior secondary schools. Thus, null hypothesis one was rejected.

Findings of this study have shown a statistically significant difference in the mean achievement scores of CBT and PBT. Findings indicated that CBT students outperformed their PBT counterparts. This finding was consistent with Oduntan et al. (2015) which reported a significant difference between CBT and PBT groups, with students performing better in CBT. It is also in conformity with the results of Hakim (2018) which revealed a significant difference among 200 Saudi female foundation year students with underperformance in PBT. This is however at variance with studies such as Hosseini et al. (2013) and Khoshsima and Toroujeni (2017) which reported a significant difference in favour of the students' PBT mean achievement scores. Nevertheless, other results in studies which were carried out to determine whether test scores differ with test mode, reported no significant difference between the two groups (Ozalp-Yaman&Cagiltay, 2010; Boeve et al., 2015; Adeniji&Ubulom, 2016; Alakyleh 2018).

Table 2 and 5 shows the difference between CBT mean achievement scores in biology among male and female students in senior secondary schools. Results indicated that female secondary school students performed slightly higher than their male counterparts in CBT. However, the independent samples t-test of significant difference conducted between CBT mean achievement scores in biology among male and female students in senior secondary schools showed no significant difference. Thus, null hypothesis two was upheld.

Results showed no statistically significant difference in CBT scores of male and female students. Nevertheless, the male and female mean score difference shows that female students' scores are slightly higher in the CBT. This suggested that female students performed slightly better in CBT than their male counterparts. This finding aligns with the findings of Hensley (2015) which examined the comparability of paper-based and Computer-based test designed to measure mathematical fluency using a mixed-factorial design with both within-and between-subjects' variables among 155 students enrolled in seven participating classrooms. Using Group Math Assessment and Diagnostic Evaluation, the study revealedno difference in how males and females performed in CBT. It is also in conformity with Alakyleh (2018) which showed no significant difference in CBT test scores of 120 male and female undergraduate students from University of Jordan. This affirmation is however opposed to Ozalp-Yaman and Cagiltay (2010), a study which evaluated students' performance on different test modes on 209 first year engineering students in chemistry. Findings indicated a significant difference between male female students in CBT achievement with a more successful female achievement score than those of their male counterparts in CBT.

Table 3 and 6 shows the difference between PBT mean achievement scores in biology among male and female students in senior secondary schools. Results indicated that male secondary school students performed slightly higher than their female counterparts in PBT. The test of significant difference conducted between PBT mean achievement scores in biology among male and female students in senior secondary schools showed no

significant difference. Thus, null hypothesis three was upheld.

Results also indicated no significant difference in PBT scores of male and female students with the male and female mean score difference showing male students' scores slightly higher in PBT. This agrees with Khoshsima et al. (2017) which revealed no statistically significant difference in the PBT scores of male and female participants in an in exploratory and experimental study that was conducted with 30 Iranian undergraduate students studying at Chabahar Maritime University. Alakyleh (2018) in its findings also confirmed this result. In contrast however, Garas and Hassan (2018) in a study which examines whether the use of technology-based assessment tool affects the examination scores of students from both genders. The study relied on experimental design and revealed a significant difference among male and female students in an introductory-level financial accounting course in PBT.

The findings of this study implies that computer technology has continued to be widespread into the 21st century as a crucial and versatile instrument for communication and education, this research work provided justification for replacing a traditional mode of test administration with a computerized one and that CBT has shown to be an equally valid and reliable test mode for student assessment in the academic environment. Hence, revealing that concerns about the validity and reliability of CBT compared to PBT seem unwarranted.

Conclusion

Based on the findings of this study, it is evident that senior secondary school students who were tested using CBT achieved better academically than those students who were tested using PBT. Findings also revealed that gender play no significant role in both CBT and PBT achievements of senior secondary school students in Taraba State.

Results from the comparison which showed CBT achievements significantly higher than those of the PBT, may not be unconnected to the effectiveness of the test taking practice and the basic training on general use of computer given to the students before administration of the CBT. Outcomes of the research which neither showed gender advantage nor disadvantage for both CBT and PBT could also be explained as evidence that points toward diminishing digital divide and gender imbalance in the use of computers and other technologies.

Recommendations

Based on the educational implications of the findings of this research, the following recommendations were made:

i. School authorities and administrators within the Education Zone should provide ICT facilities and make them accessible through organizing practice sessions to students before they are subjected to standardized computerized forms of assessments in a gender-friendly environment.
ii. Examination bodies such as JAMB and other institutions who are interested in technologically aided assessment should organize CBT mock examinations to enable the students to familiarize with the technical procedure involved in accessing and taking the test before conducting assessments on students in the Zone.
iii. Test experts in the Jalingo Education Zone should educate classroom teachers on the need for employing classroom test software and electronic gadgets which may help to prepare students on the modern day electronic challenges ahead of them.
iv. Biology teachers within the Zone should organize teacher made CBT in

their continuous assessments in classrooms that is gender-friendly to enable the students have the opportunity of familiarizing with the process and be more ICT compliant, thereby reducing their level of anxiety.

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