

Effectiveness of Computer Based and Paper Pencil Tests on the Achievement of Senior Secondary School Chemistry Students in Kano Metropolis

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Abstract

Effectiveness of Chemistry Computer Based and Paper Pencil Test on the achievement of secondary school chemistry students, was studied using causal comparative design, a sample size of 178 was used. Instrument for data collection was the Chemistry Achievement Test, (CAT). The CAT was validated using test and retest it was found with reliability coefficient of 0.89. Research questions were answered using mean and standard deviation while hypotheses, were analysed using independent sample t-test: the findings revealed that Chemistry students who were administered Paper and pencil test (PPT) perform better than their peers in computer base test (CBT). CBT chemistry examination was gender friendly. It was recommended that chemistry teachers should attend seminars and workshop on effective utilization of PPT irrespective of the number of students.

Keyword: Computer Based Test, Paper Pencil Test, Chemistry, Achievement, Gender.

Introduction

Education provides learners with skills needed for survival. The process of imparting or acquiring systematic skills and sequences of knowledge for one to be self-developed or for the development of the society at large is occasionally referred to as education. (Idris, Hassan, Ya'acob, Gill, & Awal, 2012). Through education the knowledge of the society, country is passed on, from generation to generation. Science conjoined or coupled with education gives us precise knowledge of happenings around us and transformed knowledge into technological products for the betterment and survival of mankind. For every nation to stand out in development it is imperative to build and boost its science education. (Boyi, 2013) Science Education is a continuous process of acquiring or imparting, instructions, skills, ideas, talent and knowledge of science particularly Biology, Physics and Chemistry for the development and elevation of the nation's technology and Agriculture. (Aina, 2013).

Chemistry Education can be seen as the acquisition of knowledge or ideas by an individual relevant to chemistry and it is concerned with the impartment of knowledge of properties, components, transformations and interactions of matter for students understanding and a major concrete foundations for the transformation of our national economy. It covers interaction with humans through electronics, new building materials and new sources of energy (Eledalachi, 2012; Emendu, 2014). Chemistry is the nucleus and mitochondria of all modern sciences which is the ultimate foundation upon which technology is built, it affects the people on earth, protecting and safeguarding our health, habitation, culture, heritage and wealth. Its principles, theories, techniques and effective applications are the

propellers for many industrial processes, as well as the indispensable foundations of many disciplines. The knowledge and skills of the chemistry of an individual can be certified or assessed through examination. (Chinyere, 2011; Emendu, 2014)

However, the assessment of students is quite a fundamental factor in every learning paradigm. Teachers evaluate students and learning outcomes to direct and encourage them according to their fulfilment. It is mostly known that examination determined the extent of educational objectives that have been accomplished as well as the extent to which educational institutions have served the needs of the society. (Prisacari, Anna, Agripina, 2015) Examination plays an important role in determining what is going on in the classroom, particularly in terms of teaching and learning it is incorporated as a way of coping with the educational system. (Ebimgbo, Igwe & Okafor, 2021) asserted that exam is paramount & ultimate in any institution of learning; ranging from primary to tertiary institutions of learning all over the world; it is often said that without examination certification, becomes difficult but not impossible. Examination in its entirety aims at certifying those exposed to a set of learning/training/events. It also plays a suitable role in every nation that wishes to be financially; technologically independent requires to certify his members or citizens to be academically independent and counterproductive (Ahmed and Rao, 2012). Assessing students' performance is always an important issue for educational systems. Depending on the number of students, it is not easy to implement such techniques more often. In that sense, computer-based testing (CBT) systems provide alternatives for implementing tests/exams more often on different

educational settings. (Ozalp-Yaman & Cagiltay, 2010)

While the benefits of CBTs are numerous, a foremost consideration must be whether or not CBT and Paper Pencil Test (PPT) examination are equivalent in their assessment of content knowledge and understanding. It must be assured that they reflect a student's content proficiency, not computer proficiency (Puhan, Boughton, & Kim, 2007). PPT examination/assessment are the conventional mode of student assessment, such as written test and also standardized tests that ask students to use pencils to shade in alphabets in squares or the use of pencil to write lengthy essays. CBT is often referred to as Computer-Based Assessment or e-assessment/testing which has been available in various forms for more than four decades (Sorana- Daniela and Lorentz, 2007) It is a method of administering tests in which the responses are electronically recorded, assessed, or both. It is commonly available for several admissions and post-admission tests throughout the developed countries (Oduntan, Ojuawo & Oduntan, 2015).

The use of CBTs has multitudinous prerequisite for both students, educators, and educational systems. The Joint admission and matriculation board (JAMB) introduced CBT in 2013, to minimized fraudulent practices during examinations (Hussaini & Audu, 2019) One such benefit is the real-time scoring and immediate feedback provided by CBTs (Jeong, 2012). With reduced grading time, teachers are able to increase their teaching time (Eid, 2005). Before the inception of modern technology in the sphere of education, the widespread mode of assessing students' learning outcomes in most developed and developing countries has been the conventional paper-and-pencil assessment method. However, scholars like Khoshshima Shokri. (2017); Oladimeji

and Mwuese (2018) have revealed proportionate flaws with the conventional PPT. The CBT mode of examination was first adopted to minimize the complications of missing scripts, late submission of results, and delays in marking (Ozumba, 2018). It was based on this development the researcher investigated the effectiveness of chemistry CBT when compared with chemistry PPT mode of examination among senior secondary school students.

Objectives of the study

The following objectives were raised which is to:-

1. ascertain students' performance on CBT and PPT Chemistry examination.
2. find out the influence of gender on students' performance in CBT chemistry examination.

Research Questions

1. What is the difference in students' performance in CBT and PPT Chemistry examination?
2. What is the student gender performance in CBT chemistry examination?

Hypotheses

The following hypotheses were raised

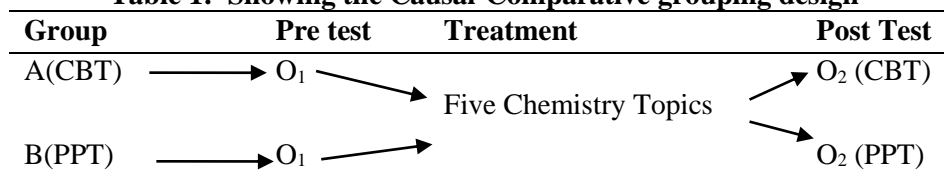
HO₁: There is no significant difference in the performance of students in CBT and PPT chemistry examination

HO₂: There is no significant difference in gender performance in CBT chemistry examination.

Methods

This study adopted the causal-comparative grouping research design. As shown in table 1;

Table 1: Showing the Causal-Comparative grouping design



The population of the study comprised of 1,985 Senior Secondary (SSII) students, from all six science and technical secondary schools in Kano state metropolis, was used for the study. A Purposive sampling technique was used, because of the nature of the study required availability of functional computer laboratory. A sample size of 178 students was utilized. Four schools, were selected, out of which 2 were female schools and the remaining 2 were male schools, due to the nature of data needed

to test the student achievement and gender, public schools in Kano are not co-educational. One male and female school were selected for CBT chemistry examination and also the remaining one male and female school were selected for PPT chemistry examination. In the two schools selected for CBT one male intact class was randomly selected out of 6 classes, which comprised of 46 male students and also one female intact class was randomly selected, out of 8 classes, from the female school which comprised of

41 female students. The procedure was repeated for the two schools selected for PPT. which comprised of 43males intact class out of 5 classes and 48female students' intact class out of 7 classes. For data collection, Chemistry Achievement Test (CAT) was used. The CAT was a performance test adapted from West African Examination Council (WAEC) with modification. The CAT contains 40 structured multiple choice (a-d) items with one correct answer and three distractors. The items in the test covered all the five topics taught for six weeks.

The instrument was given to panel of experts, which comprised of a professor, two senior lecturers, two science educators and two secondary school teachers, for validation, their input was used to improve the quality and standard of the instrument. The CAT was pilot tested with 20 students, outside the sample size and analyzed with Pearson Product Moment Correlation coefficient (PPMC) and a reliability coefficient of 0.89 was obtained. The soft copy multiple choice questions were inserted into web base software install on computers for CBT chemistry examination. The same questions were printed out on paper for PPT chemistry examination. The CAT was used for both pre-test and post-test. The pre-test was conducted/administered to ascertain the ability of the students before the same treatment. Research questions were answered using mean and standard deviation, and hypotheses were analysed using independent t-test, at 0.05 alpha level of significance.

Result

What is the difference in students' performance in CBT and PPT Chemistry examination?

In order to answer the research question, table 2 shows the mean and standard deviation of the post test scores of CAT; for both CBT & PPT.

Table 2: Mean and Standard Deviations of Students' Scores of Post Test CAT for CBT & PPT

Group	N	Mean	SD	Mean diff
A (CBT)	87	46.01	9.89	
B(PPT)	91	70.46	8.90	24.25

Table 2, shows that the mean achievement score of group B students is 70.46 while that of the group A; students is 46.01, and the mean difference is 24.25. It would appear from the difference in the mean scores that group B students scored higher in the CAT than A. In order to ascertain whether this observed difference is real or attributed to error variance, the post test scores of the CAT for both CBT and PPT was subjected to inferential testing, at 0.05 analysis of t-test, to confirmed whether to accept hypothesis one or to reject it, as shown in Table 3.

Table: 3. Summary of t-test Analysis of post test Scores of Chemistry CBT and PPT

Group	N	Mean	SD	Std. Err	df	t-Val	P-Val
A	87	24.25	9.89	1.20	176	17.167	0.00*
B	91		8.90	1.33			

*The difference is highly significance <0.05

A brief look at the finding in Table: 3. showed the result of t-test analyses of post-test, CAT scores of PPT and CBT chemistry examinations, the result revealed a statistically significant difference at the level of $p < .05$ (t-value = 17.167; $p = .000 < .05$). However; this result indicates that the students that took PPT chemistry examination attained higher success after the (treatment) when compared to their peers in the CBT chemistry examination group. Performance is significant, this is because its probability value of 0.0001 is shown to be lower than the level of 0.05 at which it is being tested. Therefore, the null hypothesis, which says there is no significant difference in the performance of students in CBT and PPT chemistry examination; is rejected. The alternate hypothesis is accepted in favour of PPT.

Table 4: Mean and standard deviation of students' scores of post-test CAT for CBT; Female and Male

Gender	Mean	SD	N	Mean diff
Female	71.34	8.47	41	1.98
Male	69.36	9.27	46	

*The difference is highly insignificance <0.05

Table 4, shows that the mean performance score of group female students is 71.34 while that of the male students is 69.36; it would appear from the difference in the mean scores to be 1.98 which is inconsequential; male students scored slightly higher in the CBT chemistry examination than the female students. While the standard deviation values was 9.27 for the male and 9.47 for the female signifying that the majority students tend to have scores that are very close to the mean. In order to ascertain whether this observed difference is real or attributed to error variance, this result was subjected to inferential testing of t-test as shown as shown in Table 5

Table: 5. Summary of t-test Analysis of post test Scores of CBT Chemistry Examination for Female and Male

Group	N	Mean	SD	Std. Err	df	t-Val	P-Val
Female	41	64.588	9.567	1.108	75		0.306
Male	46	69.965	10.012	1.238		1.031	

A look at the findings in Table: 5. showed that the results of t-test applied to the post CBT chemistry examination scores of the Female and Male, students who took chemistry examination in CBT revealed a statistically insignificant difference at the level of 0.05 ($t\text{-value} = 1.031$; $p = .306$; $> .05$); this result indicates that, Performance of both gender was insignificant, this is because its probability value was 0.306, as shown to be higher than the level of 0.05 at which it was being tested. Therefore, the null hypothesis. Which says there is no significant difference in gender performance in CBT chemistry examination is accepted. The alternate hypothesis is rejected. Therefore, the earlier difference, was not real.

Discussion

From the finding, table 3. Shows analysis of t-test on SPSS which revealed a significant difference, the P value is lower than, 0.05 level of significance. This result indicates that group B students attained higher success after the treatment application when compared to their peers in group A, who conducted their chemistry examination in CBT. As a result, it can be argued that the use CBT chemistry mode of examination is not effective in examining/assessing students' chemistry performance; the conventional chemistry PPT has proved effective. Certain studies have been found to confirm the present studies. Monirosadat, Mohamad, Mostafa (2014) & Coniam (2006); the results of their studies revealed that participants performed better on paper-based tests than computer-based test. The findings are in contrast with those who argue that there is no any difference between CBT and PPT chemistry examination, if the test administration condition is equivalent except the influence of students' preference in computer-based test rather than paper-based test mode (Bachman, 2000; Jamieson, 2005; Douglas & Hegelheimer, 2007; Samuel, Ngozi & Agnes (2021) argues that CBT is only effective mode of conducting examinations especially when it concerns large classes because it helped to reduce stress, missing scripts, and examination malpractices. Ambiyar, Purwati, & Saputra, (2019). Findings disagree with the study, where they confirmed that the CBT is effective in assessing the performance of student. The difference is that, the study was conducted at Pelita Indonesia College of Computer Science; on computer students. Nwoke, Osuji, & Agi (2017). In a study title the Influence of computer-based test (CBT) on examination malpractice in public examinations revealed that CBT examination is effective reducing examination malpractice among students in public examination like JAMB.

In summary from the result, of the findings it can be argued that the use of the PPT chemistry examination is more effective in conducting examination among chemistry students it may be because they are conversant with the mode of examination, CBT on the other hand which is relatively unique mode of examination is entirely different from what they are used to, but if properly implemented it helps to minimised malpractices and missing scripts. However, several disadvantages were discovered in the process, such as loss of network connection, power failures, during the examination, computer malfunction in the process of examination, are prevalent challenges in CBT. Onyibe, Nwachi-Ikpor and Abdulhakim (2015) pointed out, that one of the challenges of CBT is the gross inadequacy and expensive nature of ICT infrastructure in the country. The contradictions in the findings of these studies with the present one may be due the nature of concept to be learned, control of intervening variable, different design of the study and statistical analysis etc. Therefore, some more such researches are needed to arrive at valid generalization.

However, it can also be said that there is no any significant difference in the performance in female and male, as shown in table 5; the result, clearly argue that there is no any special preference in terms of both the knowledge and operation of the computer between gender. Therefore, gender disparity is highly overcome, while using CBT chemistry exams.

Conclusion

In view of the findings of the study, the following conclusions were made.

1. There was a significant difference in the performance of students in CBT chemistry examination when compared to its counterparts in PPT, in favour of PPT.
2. Gender has no significant effects on students, CBT chemistry examination performance.

Recommendations

With respect to the findings of the study, the following recommendations were made.

1. It is recommended that examination bodies, school authorities and chemistry teachers should attend seminars and workshops on effective utilization of PPT for chemistry examination.
2. Ministry of education should train chemistry teachers on how to use and construct PPT chemistry examination irrespective of the students' population. Teacher and students' ratio should be highly implemented and maintained.
3. Authorities should train public school teachers on the operation of computers, in turn exposed

their students to CBT examination, and government should address the challenges of CBT and produce available functional computer laboratory in schools, to boost the speed of assessment due to technological advancement in the field of education across the globe.

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