

The Juxtaposition of Analogue and Digital Strategies in Mathematics Examinations: A Case for Blended Approach

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Abstract

This study sought to establish the invaluableness of blended approach by comparing the outcomes of Computer-Based (CBE) with Paper-Based Examinations (PBE) in post-secondary level of Education. Descriptive survey research design was adopted for the study. The population for the study comprised of the 528 GSE113 students in the school of Science for the year 2017/2018 and 2018/2019 sessions of Ikere College of Education, Ikere Ekiti, Nigeria. 478 students' results were purposively selected as the sample for this study. The two different results were compares and it was observed that students perform better in manual examination (PBE) than E-examination (CBE) despite several researches that have established the effectiveness of computer-based over paper-based (analogue) examinations. Besides, the results of male students were compared with females' results in both side. It was observed that gender has effect on performance of students in PBE but has no effect on students' performance in CBE. Consequent to the findings of the study, it was recommended that blended approach which combines the two methods should be engaged especially for subjects that are majorly of calculations such as Mathematics. Also learners' opinion should be considered on the type of examination preferred; either CBE or manual, especially in Mathematics courses.

Keywords: Computer-Based-Examination, Results, Paper-Based-Examination, Blended Learning,

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Introduction

Learners' performance is a very vital point in the learning process, it affects the learner as well as the teacher either positively or negatively. For learners especially in the higher level of learning such as College of Education, evaluation plays an important role in the measurement of level of attainment in a topic, semester or session. Ukwueze and Eya (2018), describe evaluation as the core process of measuring the effectiveness of the teacher, students' achievement and the quality of study program. It is not only the learners that are evaluated, only that the means of evaluation differs. Weak performance reduces the Grade Point Average (GPA) of a student which eventually would be used to calculate the Cumulative Grade Point Average (CGPA). Hasan, et al. (2017) defined GPA and CGPA as the numeric depiction of students' performance in their academic years. This definition clarifies the two as the representation of the ability of the individual student in the possession. The tri submitted that CGPA helps and assists in the production of better students with good qualities and excellence. Weak CGPA can lead to several unfavourable occurrences in life such as joblessness, incompetency, discouragement, unfulfilled dreams, delay in admission for higher programs and narrow chance of skills demonstration. Consequently, the means of measuring learners' performance should be of topmost value to the child, that is, it should be the most suitable and convenient method so as to promote the performance of the learner.

The conventional Paper-based examination (PBE) is also known as analogue or formal way of writing examination. As the name implies, it involves the use of paper and pen in answering examination. Since the inception of e-examination which is computer based examination (CBE), the formal seems to be fading away in a geometrical form. The usefulness of computer in Education is open ended. This is highly appreciated by the inclusion of Computer Based Examination (CBE) into the curriculum with ease. CBE can also be described as Electronic Assessment, online Assessment or Digital Assessment. In many cases, Computer-Based Examination (CBE) and Computer Based Test (CBT) has been used in the summative examination in higher schools of learning. Shraim (2019) observed that computer based (online) examination was preferred by undergraduates as it was regarded as reliable, valid and secured compared with paper-based examinations. Shriam (2019) further expatiated on the usefulness of online exam as a simplification of paper-based. This reveals the ease in the marking and recording of students' scores especially when the class is large. Al-Qdah and Ababneh (2017) and James (2016) also submitted that the results of computer based evaluation increased accuracy and reliability in comparison with the traditional assessment. Jamil, et al (2012) observed that a lot of teachers prefer computer-based examination to Paper-based. They further explained that Computer-based examination have many advantages over paper-based such as bringing ease to; marking and scoring, recording and computation, preservation and accessibility of scores. Hallstedt and Ghaderi (2018) itemized the benefits of online testing which include; less time consumption, easy for large class testing, accommodation of diverse languages and less expensiveness.

Going by the advantages of the use of computer in education, one may be carried away from considering the fact that there could be aspects in which the use of computer could be negatively skewed. As much as CBE could be of benefit in conducting examinations in some subjects such as languages, Civic, Government, Political Science, and other subject or courses in the line of prose that will not involve calculations, cognizance should be given to considering how the use of CBE in subjects that involves calculations are affected. Theory examinations in Mathematics are marked step by step. It is very possible for a candidate to miss the answer for a question and still get some marks. For instance, if there are ten steps in

the process of solving a question, each step carries one mark making a total of 10 marks for the question. A candidate who got it wrong after step 6 will still bag 6 marks out of 10. This is not permitted in CBE, missing the option means losing the mark. Work had been done on the on the conduct of examination using paper and pen. For instance, Osuji (2014) and Ukwueze and Eya (2018) submitted that students perform better in pen and paper examinations.

Hallstedt and Ghaderi (2018) submitted that there had been several investigations on comparability of scores between paper and pencil and digital tests. They were of the opinion that there are good reasons for digital testing and the trend with computerized assessment is increasing. Jamil and Tariq (2012) were able to find out that some teachers preferred paper-based examinations though others advocated CB. The conclusion of the result of Heidelberg Rechen Test (HRT) test carried out by Hallstedt and Ghaderi (2018) shows that students produced generally lower scores in pictorial counting scale on the tablets This is in favour with paper-based tests and a revelation to the fact that there are topics in mathematics that permeate better performance in paper-based examination. The skills that are mathematical may be going to extinction especially in the early stage of mathematics, when some topics taught would not be easily examined, for instance "Graph" as a topic may not be easily examined in CBE because of its nature and the content.

This brought into lime-light the fact that there could be people with their interest on paper based examinations. The idea of full e-examination may be injurious to many learners especially in the localized environment where the use and learning with computer have constrains. Since there is not yet a concessive conclusion on the better out of CBE and PBE, this study is worth working upon.

Statement of the Problem

The researcher observed that the results of some learners in continuous assessment (CA) which majorly comprises assignment and teacher-made-tests, are better compared with the CBE which is summative examinations, since the percentage of summative examination (60%) is higher compared with that of CA (40%). It is easy for a child that is vast or prefers Paper Based Examination to have his/her CGPA dropping to undesirable value if the child continuously has only CBE examinations. In the view of this, there is the need to compare Paper Base Examination with E-examination as much as many researchers have wholly supported blended teaching and conduct of E-examinations (Abdulbaqi & Ajayi, 2021; Fazal & Bryant, 2019; Clark, 2015). This study purposefully compared the CBE examination with paper-base for the benefit of those learners that may prefer paper base examination not to be sandwiched or completely neglected while e-examination favourites trend. It also aimed at bringing into limelight the merits of blended examinations.

Research Questions

1. What is the students' performance in GSE 113 PBE and CBE?
2. What is the students' performance in GSE 113 PBE and CBE by gender?

Research Hypotheses

The following null hypotheses were postulated.

1. There is no significant difference between students' performance in GSE 113 PBE and CBE.
2. There is no significant gender difference in students' performance in GSE 113 PBE.
3. There is no significant gender difference in students' performance in GSE 113 CBE

Research Method

Quantitative comparative research design of the survey type was adopted for the study. This design was considered appropriate, because it described the existing situation as it occurs

without the manipulation of variables. Two sessions' result - analyses for General Studies in Education 113 (GSE 113) - Mathematics in General Studies 1 for the school of Sciences were compared. The population for the study comprises all the 528. The sample consists of 478 students that were purposively selected for GSE 113 in the years 2017/2018 and 2018/2019 respectively. Also the result of female students were compared with the male results to determine any significant difference by gender. Two research questions were raised while three null hypotheses were generated. The frequency of students' performance for each grade was obtained from grade A to F, data were analysed descriptively. For the research questions, frequencies and percentages were found and graphically represented in bar charts while the hypotheses were tested using t-test. It is hoped that the better means of examining the students would be discovered and this would help to improve the performance of the students especially in Mathematics and Mathematics related courses.

Results

Research Question 1: What is the students' performance in GSE 113 PBE and CBE?

Table 1: Descriptive analysis of students' performance in GSE 113 PBE and CBE

		PBE		CBE		Difference
Grade		Frequency	Percent	Frequency	Percent	
Valid	A	24	10.0	4	1.7	20
	B	44	18.4	4	1.7	40
	C	42	17.6	15	6.3	27
	D	50	20.9	26	10.9	24
	E	47	19.7	126	52.7	79
	F	32	13.4	64	26.8	32
	Total		239	100.0	239	100.0
Mean Grade Point		3.3808		2.0837		1.2971
Standard Deviation		1.5535		1.0215		0.5320

Source: self computed. PBE= Paper-Based Examination. CBE= Computer-Based Examination. A-F= Grades of students. A=70% upward; B=(60-69)%; C=(50-59)%; D=(45-49); E= (40-44)%; F= (1-39)%.

In answering the first research question, table 1 shows the analyses of the grades obtained by the students that wrote Paper-Based Examination (PBE) in GSE 113 and those that wrote Computer-Based Examination (CBE) in GSE 113. The total number of students that wrote PBE is 239 which is equivalent to the number of students that wrote CBE, that is, 239. The frequency of the students that had A in PBE is 24 which is 10.0% of the total number for PBE. For CBE, 4 students had A which is 1.7% of the total number that wrote CBE. The difference of the two frequencies is 20. Frequency for B in PBE is 44 which is 18.4% of the total for PBE while the frequency for B in CBE is 4, 1.7% of the total students that sat for CBE, the difference in the frequencies is 40. The frequency of students that had C as their grade in PBE is 42 which is 17.6% of the total number of students that sat for PBE.

Also, the frequency of students that had C in CBE is 15 which is 6.3% of the total number of students that wrote CBE examination. Juxtaposing these two frequencies, the difference is 27. Students that obtained D grade in PBE group are 50 in number, their percentage is 20.9 based on the number in the group. For CBE, 26 students bagged D which is 10.9% of the total

number in the group. The frequency difference of the two groups is 24. PBE students that had grade E are 47, that is, 19.7% of the total number of students in PBE while the number that had E in CBE is 126 with their percentage being 52.7. The difference in frequency is 79. The last grade is F. 32 students in PBE group had F which is 13.4% of the total number in that group. Also, 64 students had F in CBE group which is 26.8% of the number of students in the group the difference between the two groups' frequency is 32. The sum of students in the two groups is 478. The students' performance in GSE 113 PBE and CBE is further depicted in Figure 1.

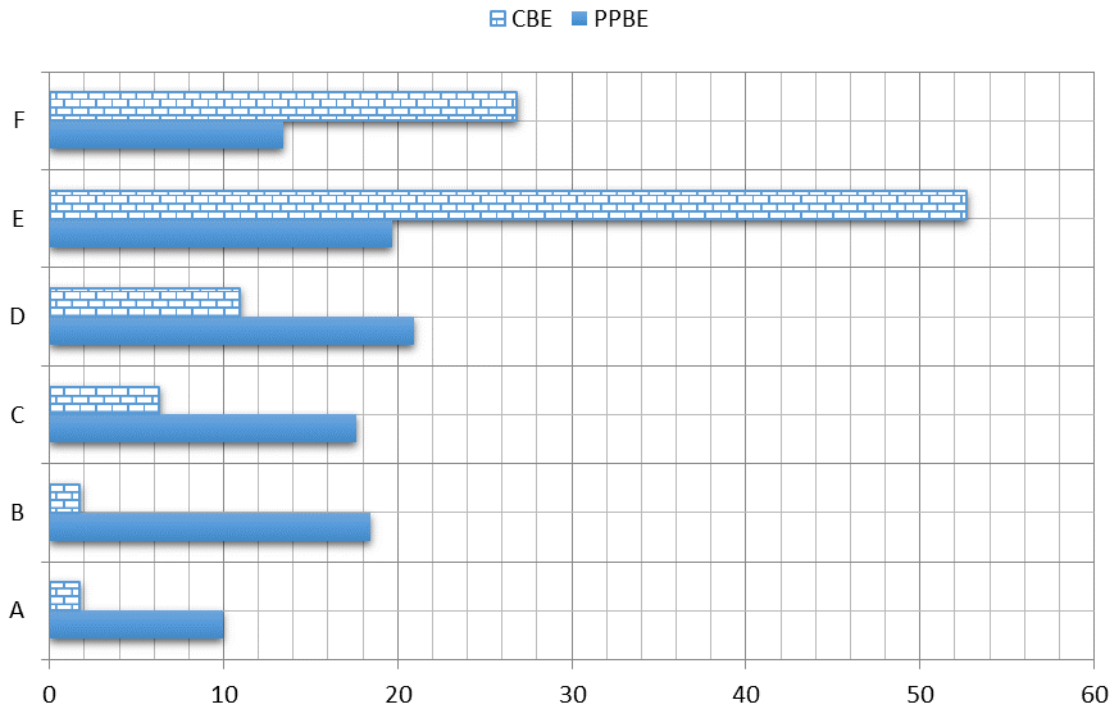


Figure 1 shows the Percentage of Grades in GSE 113 PBE and CBE. This is the diagrammatical representation of the information on table 1.

Research Question 2: What is the students' performance in GSE 113 PBE and CBE by gender?

Table 2: Descriptive analysis of students' performance in GSE 113 PBE and CBE by gender

Grade	PBE					CBE					
	MALE		FEMALE		Difference	MALE		FEMALE		Difference	
	N	%	N	%		N	%	N	%		
Valid	A	15	16.3	9	6.1	6	3	2.8	1	0.8	2
	B	20	21.7	24	16.3	4	2	1.9	2	1.5	0
	C	15	16.3	27	18.4	12	7	6.5	8	6.1	1
	D	21	22.8	29	19.7	8	18	16.7	8	6.1	10
	E	12	13.0	35	23.8	23	41	38.0	85	64.9	44
	F	9	9.8	23	15.6	14	37	34.3	27	20.6	10
	Total	92	100.0	147	100.0		108	100.0	131	100.0	
Mean Grade Point	3.7609		3.1429		0.6180	2.1204		2.0534		0.0670	



Standard Deviation	1.5715	1.4989	0.0726	1.1738	0.8798	0.2940
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Source: Self computed. N=Number.

Table 2 shows the grades obtained by both male and female students that wrote GSE 113 in Paper-Based Examination (PBE) and Computer-Based Examination (CBE). The total number of students that wrote PBE is 239, 92 males and 147 females. For CBE, 239 students wrote the examination, 108 males and 131 females. The difference (0.6180) in the mean grade points of male (3.7609) and female (3.1429) that wrote PBE is not statistically significant. The Standard Deviation for male (1.5715) and female (1.4989) also had no statistical significant. These show that there is no difference in the performance of males and females in PBE. Also, the difference (0.0670) in the mean grade points of males (2.1204) and female (2.0534) that wrote CBE is not statistically significance. The Standard Deviation for males (1.1738) and females (0.8798) also had no statistical significance. These show that there is no difference in the performance of males and females in CBE. The students' performance in GSE 113 PBE and CBE by gender is further depicted in Figure 2.

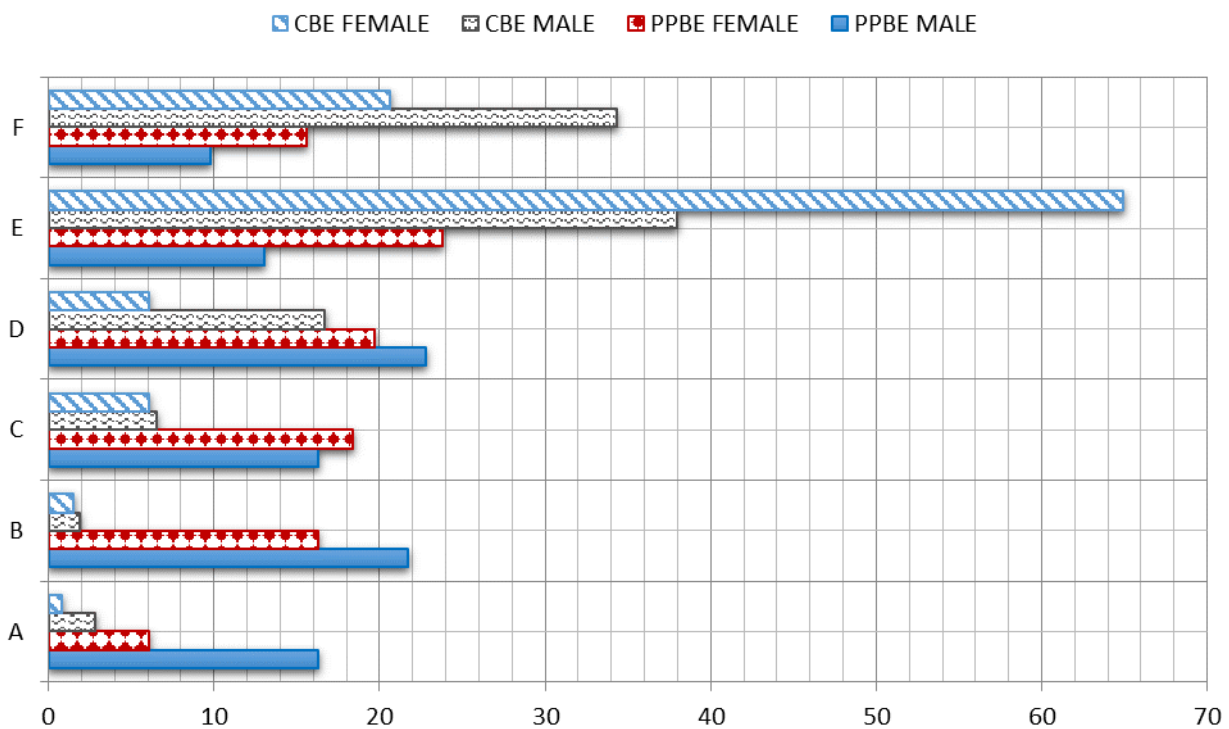


Figure 2 shows the Percentage of Grades in GSE 113 PBE and CBE by gender. This is the diagrammatical representation of the information on table 2.

Testing of Hypotheses

Hypothesis 1: There is no significant difference between students' performance in GSE 113 PBE and CBE.

Table 3: Descriptive analysis of students' performance in GSE 113 PBE and CBE

Variations	N	Mean	SD	df	tcal	P
GSE 113 PBE	239	3.38	1.55	476	10.831*	0.000
GSE 113 CBE	239	2.08	1.02			

*P<0.05



Table 3 shows that the t-cal value of 10.831 was significant because the P value (0.000) < 0.05. This implies that null hypothesis was rejected. Hence, there was significant difference between students' performance in GSE 113 PBE and CBE in favour of students in performance in GSE 113 PBE.

Hypothesis 2: There is no significant gender difference in students' performance in GSE 113 PBE.

Table 4: t-test analysis of gender difference in students' performance in GSE 113 PBE

Variations	N	Mean	SD	df	t _{cal}	P
Male	92	3.76	1.57	237	3.022*	0.037
Female	147	3.14	1.50			

*P<0.05

Table 4 shows that the t-cal value of 3.022 was significant because the P value (0.037) < 0.05. This implies that null hypothesis was rejected. Hence, there was significant gender difference in students' performance in GSE 113 PBE in favour of male students.

Hypothesis 3: There is no significant gender difference in students' performance in GSE 113 CBE.

Table 5: t-test analysis of gender difference in students' performance in GSE 113 CBE

Variations	N	Mean	SD	df	t _{cal}	P
Male	108	2.12	1.17	237	0.513	0.711
Female	131	2.05	0.88			

P>0.05

Table 5 shows that the t-cal value of 0.513 was not significant because the P value (0.711) > 0.05. This implies that null hypothesis was not rejected. Hence, there was no significant gender difference in students' performance in GSE 113 CBE.

Discussion

This study juxtaposed students' performances in PBE and CBE by comparing the results of GSE 113 in two different sessions to predict the need of blended examination. Many researchers have concluded by observations that CBE (e-examination) is better than PBE (Shute & Rahimi 2016; Nurhikmah, et al., 2021). Ordinarily, the computer appreciation and the overhauling usefulness of computer can gender the belief that PBE examinations will no more be needed. Literature examined during the course of this study revealed the fact that no consensus had been reached on which of the two types of examinations should be preferred. The findings in this study showed that students that wrote PBE performed better than the students that wrote CBE. This supports the claims of Osuji (2014) and Ukwueze and Eya (2018) that students perform better in pen and paper examinations.

To give consideration to both learners that have free access to computer practices and those that maybe restricted as a result of any challenge, blended assessment approach could be considered appropriate. In general, Blended Learning is when a learner or group of learners combine face-to-face learning with online learning for the benefit of achieving the set goals over a particular course or topic at the specified time.

The findings of the study also revealed that there was gender difference in students' performance in GSE 113 PBE in favour of male students. Male students performed better than

female students in GSE 113 PBE. However, it was not the same for gender difference in GSE 113 CBE as there was no gender difference in students' performance in GSE 113 CBE.

Conclusion

The results of students that sat for Paper Based Examination (PBE) were compared with the results of students that sat for Computer Based Examination (CBE) to establish any statistical difference. It was observed that students that sat for PBE performed better than the students that sat for CBE. The results of female students that sat for PBE were compared with the results of their male counterparts for significant difference. The result showed that there was gender effect on PBE. Likewise, the results of female students that wrote CBE were compared with the results of their male counterparts for statistical difference. But it was established that there was no significant difference in their performance.

This research would add to literature as the result of PBE and CBE were compared to determine their effects on students' performance. Since the findings of this study negate the assumptions and findings of some researchers that believe every examination should be e-examination, the idea of blended examination would be appropriate. Blended examination is an approach that combines offline and online means of examining students. Blended examination can take different shapes. For instance, questions can be displayed on the digital board while students who prefer PBE will write and submit script. This will prevent the phobia of manipulating computer. As discovered in the reviewed literature, there could be many reasons that can lead students to prefer PBE such as poor family background, lack of computer for practice and poor knowledge of computer usage.

Recommendations

Based on the findings of this research, the following recommendations were made by the researcher:

1. Students should be allowed to choose the type of examination he/she will prefer
2. Instructors should take cognisance of the performance of students in the formative examinations that are mostly PBE to compare individual student's result to the result of summative assessment which are mostly CBE.
3. The management should support the idea of blended examination to give equal advantage to every candidate.
4. Future research is recommended on what the reason could have being that made PBE students performed better than students that wrote CBE.

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