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SSSCE/WASSCE Results as a Predictor of HND Statistics Results (A Case Study of Cape Coast Polytechnic, Cape Coast, Ghana)

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Abstract:

The study aimed at assessing the predictive validity of the SSSCE/WASSCE results for the 3 year HND Statistics Programme in the Polytechnics in Ghana. Data for the research were secondary data from the Statistics and Computer Studies Department of Cape Coast Polytechnic, comprising SSSCE/WASSCE results or aggregates, and CGPAs of students who gained admission into the HND programme in this department and graduated in the years 2007 to 2013. Thus, a sample of seven consecutive years was taken. In all, a sample size of 182 students was taken. The data were analysed by using mainly regression, one-way ANOVA, and correlation analysis with the aid of MINITAB 15. Results of this study were as follows: The Pearson's correlation between students' SSSCE/WASSCE results and CGPAs was $r = -0.212$. The regression of students' CGPA on SSSCE/WASSCE aggregates was $CGPA = 4.03 - 0.0458X$. However, it was found that predictions of students' CGPAs would come with very bad precisions. Also, the value of the correlation coefficient was found to be different from the original r when only students with subject related backgrounds (Elective Mathematics in this case) were considered, though, the difference was not significant at 0.5 level of significance.

Keywords: Senior Secondary School Certificate Examination (SSSCE), West African Secondary School Certificate Examination (WASSCE), West Africa Examinations Council (WAEC), Predictive Validity, Curriculum, Formative Assessment, Summative Assessments, Academic Background, Academic Achievement.

1. Introduction

The Polytechnics in Ghana were established to complement the role of the universities to increase access to tertiary education for the training of middle and higher level manpower for the country. The new Polytechnic Act of 2007, Act 745 has given the Polytechnics the mandate to run degree programmes. Currently, Ghana has ten public Polytechnics, with one in each of the ten geographical regional capitals.

The Polytechnics accept applicants with either Senior Secondary School Certificate Examination (SSSCE) results of aggregate 24 or better for six best subjects, or West Africa Senior Secondary School Examination (WASSCE) results of aggregate 36 or better, also for six best subjects, and other equivalents as the minimum requirement for admission to study various 3-year Higher National Diploma (HND) programmes.

Grade	Definition	Interpretation (%)
A1	Excellent	80 – 100
B2	Very Good	70 – 79
B3	Good	65 – 69
C4	Credit	60 – 64
C5	Credit	55 – 59
C6	Credit	50 – 54
D7	Pass	45 – 49
E8	Pass	40 – 44
F9	Fail	0 – 39

Table 1: WAEC Grading System and Interpretation

Source: National Board for Polytechnics and Technical Examinations (NABPTEX)

In Ghana, the West African Examinations Council (WAEC) is responsible for several examinations. The main ones are the Basic Education Certificate Examination (BECE) for Junior High Schools and the West Africa Senior Secondary Certificate Examination (WASSCE) for Senior High Schools, which replaced the Senior Secondary School Certificate Examination (SSSCE) in 2004. The WASSCE examination is currently, the pathway for majority of the candidates who enter Tertiary Institutions in Ghana. Generally, WAEC grading system interpretation stands as in Table 1 above:

On August 5, 2007, a statement was jointly signed by Professor Jophus Anamuah-Mensah, Chairman of Vice Chancellors Council and Mr. Ato Essuman, Chief Director of the Ministry of Education to address the concerns raised by applicants and other stakeholders regarding the interpretation of the grades for admission of WASSCE candidates to the respective programmes of study in the Universities. The statement said WASSCE candidates should have credit in both the core and elective subjects from A1 to C6 to qualify for admission and in computing the aggregates, the following numerical values should apply: A1 is equivalent to 1 (A1 SSSCE); B2 is 2 (B in SSSCE); B3 is 3 (C in SSSCE); and C4, C5, C6 are all equivalent to 4 (D in SSSCE). The rest are the E8 which is 5 (E in SSSCE) and F9, fail. The above interpretation to the SSSCE/WASSCE grading system has since been used in the admission processes in all the Polytechnics. Every institution has got established principles or guidelines through which students are assessed. In the Polytechnics in Ghana, the students go through Semester programmes, where both Formative and Summative assessments are used. The assessment is done in 40% and 60% for Continuous Assessment and End - of- Semester Examinations respectively.

Table 2 shows the summary of the interpretation of the HND Grading System, and Table 3, shows the classification of the HND awards based on the cumulated grade point average (CGPA) at the end of the 3-year programme of study.

Score Range	Grade Awarded	Grade Point
100 – 85	A+	5.00
80 – 84	A	4.50
75 – 79	B+	4.00
70 – 74	B	3.50
65 – 69	C+	3.00
60 – 64	C	2.50
55 – 59	D+	2.00
50 – 54	D	1.50
Below 50	F	0

Table 2: Summary of Interpretation of HND Grading System

Source: National Board for Polytechnics and Technical Examinations (NABPTEX)

Cumulated GPA	Class of Award
4.00 – 5.00	First Class
3.00 – 3.99	Second Class Upper Division
2.00 – 2.99	Second Class Lower Division
1.55 – 1.99	Pass
Below 1.50	Fail

Table 3: Interpretation of the HND Classes Awarded

Source: National Board for Polytechnics and Technical Examinations (NABPTEX)

1.1. Justification for the Study

The outcome of this study was expected to provide information on the strength of the SSCE/WASSCE results with respect to the Polytechnic HND programmes and educate the public on the problems associated with it.

The study was anticipated to provide information to the Curriculum Research and Development Division (CRDD) of Ghana Education Service (GES) in reviewing the curriculum at the basic and secondary levels, depending on the outcome of the research. Also, it was anticipated to provide information on any shortfalls in the admissions requirements into the Polytechnic HND Statistics programmes, if any. In the process of conducting this research, the intention was to highlight through recommendations, a way which can lead the lecturer, school authorities and curriculum planners towards improving students' academic performance, considering their academic backgrounds. It is expected that if the above mentioned stakeholders in education consider the recommendations, the journey towards achieving high standard of polytechnic education in Ghana would yield positive results.

1.2. Purpose of the Study

In recent decades, there has been a widespread concern about the strength of students' SSSCE and WASSCE results in relations to the studies in the Polytechnics and the Tertiary Institutions in Ghana. One of the researchers after teaching Statistics courses in the department of Mathematics, Statistics and Computer Science for eight years in Cape Coast Polytechnic, has been having mixed feelings as to whether the SSSCE/WASSCE background of the student really informs about the final award by the Polytechnic authority. If it does, then it appears that there are sometimes deviations in students' performances, so far as the predictive powers of their High School results are concerned.

It is against this background that this study is being conducted to critically examine the impact of SSSCE/WASSCE results on the performance and the final GPA the students obtained at the end of their 3-year HND Statistics programme. The purpose of this study

was therefore to assess the predictive validity of the SSSCE/WASSCE results for the 3-year HND Statistics programme in the Cape Coast Polytechnic. Also, the study was to find out the effect of possession of a higher mathematical background on the predictive validity of SSSCE/WASSCE grades.

1.3. Research Questions

The study sought to find answers to the following questions:

1. Are there significant differences among different years' graduating CGPAs in the Statistics Department?
2. To what extent can students' SSSCE or WASSCE results be relied on in predicting one's HND results?
3. What is the regression equation that can best be used to predict incoming students' CGPA for HND Statistics Programme?
4. Does the SSSCE or WASSCE Mathematics have impact on the regression equation?

1.4. Limitations of the Study

It is obvious that students' individual subjects offered at the Senior Secondary School (SSS)/Senior High School (SHS) level play vital a role in their studies at the tertiary level. For example, one will expect students who had never read Economics in the Senior High School to have more difficulty in Economics which is offered as a course in the HND Statistics programme, than one who has an economics background already. Though the research will consider the differences in the academic backgrounds of Mathematics, the effects by the various backgrounds such as mentioned earlier, may be hidden in the overall results.

2. Review of Related Literature

2.1. Theoretical Review

A mathematician and a statistician of the first order, Karl Pearson (1857–1936), who was a student of Sir Francis Galton (1822 – 1911) needs to be acknowledged for his immense contribution to the development of the concept of correlation. He derived the mathematical underpinnings of regression (then referred to as reversion), correlation, and covariation of observable phenomena in a manner that allowed Galton to make inferences about unobservable phenomena (Anastasi, 1982; Cunningham, 1986; Flanagan et al., 1997). It is worthy of noting that the correlation coefficient of Galton and Pearson continues to be used as the basis for reliability and validity coefficients in educational and psychological testing today. The concepts of correlation and regression are primarily being used as the basis for this study.

2.2. Empirical Review

Not much has been done in the area of research into predictors of student academic achievements in tertiary institutions as compared to the number of possible predictors (entrance examinations) of students' results. However, recently, some interesting investigations were made into Scholastic Aptitude Test (SAT), International English Language Testing System (IELTS) and Test of English as a Foreign Language (TOEFL), as well as some other factors as predictors of student academic achievements.

The study conducted by Shaw, Kobrin, Patterson, & Mattern (2012) examined the differential validity of the SAT for predicting cumulative GPA (CGPA) through the second year of college by college major, as well as the differential prediction of CGPA by college major across student subgroups. This study revealed that the relationship between SAT and CGPA varied somewhat by major, as well as by major and subgroup (e.g., gender, ethnicity and parental educational level), and this variability was likely due to the differences in the nature of the college course work, grading practices, student self-selection and academic cultures (e.g., male dominated or highly competitive) across major.

Another interesting investigation was the one conducted by Cotton and Conrow (1998). The purpose of the research study was to investigate the relationship between IELTS and academic outcomes, as well as the extent to which IELTS predicts the kinds of language difficulties international students experience while studying in Australia. Correlations were calculated between the IELTS scores of the student group under investigation of three measures of academic achievement: Grade Point Averages, academic staff ratings of student performance and students' self-ratings of performance. No positive correlations were found overall. However, the reading and writing subtest scores correlated at 0.36 and 0.34 with staff ratings of academic achievement, and 0.46 and 0.39 with students/self-estimates of academic performance in second semester. No positive correlations were found between IELTS scores and language difficulties students reported with aspects of their course work. Qualitative data indicated that language difficulties are one of many variables affecting academic achievement. Several key intervening variables were briefly investigated, namely, the amount of English language tuition received, motivation, cultural adjustment and welfare difficulties experienced by international students. In addition, students and staff reported their views of IELTS, which was generally perceived to be a fair test.

"A Comparison of IELTS and TOEFL as Predictors of Academic Success" was a research study conducted by Hill et al. (2010) in the University of Melbourne. The main question for their study was the usefulness of IELTS and TOEFL (the two main measures of English Language Proficiency (ELP) used for selection to universities in Australia) respectively as predictors of readiness for the Australian academic context. However, earlier research suggests that ELP is only one of a number of factors impinging on academic success (Davies 1990; Criper & Davies, 1988, cited in the report of Hill et al., 2010). The study was also concerned with additional factors which may influence academic progress, such as the effect of English language support. The relationship between GPA and IELTS scores was found to be moderately strong whereas the correlation between achievement and TOEFL score was relatively weak. These results appear to be consistent with the results of previous studies. In the interview and questionnaire data students identified

non-linguistic factors affecting their academic performance which may help to explain the weak correlations between ELP score and academic success.

3. Research Methodology

3.1. Research Design

The research design chosen for this study was the Correlational Research Design. In a correlational design, you simply measure variables (without manipulating them) and then analyze the data to see whether the variables are related. The statistical tools you use are those that measure the strength and direction of the relationship (i.e., correlation coefficients). It is much easier to establish cause and effect relationships when you manipulate one of the variables (i.e., the independent variable) The correlational design was chosen because in our case, the purpose of the study was to assess the strength of the relationship (if any) between students' SSCE/WASSCE results and their HND results, and also to find out the effect of a stronger mathematical background on the strength. According to Osuala (2001), correlational research is useful in a situation such as our case.

3.2. Tools for Data Collection

The data for the study were secondary data obtained from the Mathematics/Statistics Department of Cape Coast Polytechnic. The data consisted of the information on students' departmental entry requirements, entry qualification as well as students' Cumulative Grade Point Averages (CGPA). The years that were considered for the study are 2007, 2008, 2009, 2010, 2011, 2012 and 2013 graduations. In each of the graduating years, all the students who were admitted with only SSSCE or WASSCE certificates were selected, and their CGPAs as well as SSSCE or WASSCE results recorded.

After collection of data, the bulk data were systematically analysed, using tables and graphs (scatterplots and Box-and-Whisker) as well as descriptive statistics, and further analyses involving hypotheses testing such as analysis of variance (ANOVA), and also correlation and regression analysis to complement the former. The statistical software used was MINITAB 15.

4. Results and Discussion of Findings

4.1. Results

4.1.1. Are there Significant Differences among the Years' CGPAs of Graduating HND Students in Statistics?

Figure 1 shows the Box-and-Whisker plots of the final CGPAs of the students who had their HND Statistics from the years 2007 to 2013. This reveals various features of the data such as the lowest and highest CGPAs of the candidates, the median and quartiles of the CGPAs forming the data. From Figure 1, it appears that the 2012-year group graduated with the best CGPAs, with some first class (CGPA above 4.00). This appears to be followed by those who graduated in 2007, though it has three outliers that might affect the mean of the CGPAs. The 2010-year group has a beautiful normal distribution but unfortunately appears to have the worst final CGPAs. Looking at the trend of the mean plot, one may immediately conclude that there are differences among these groups of CGPAs. The next is the result of the Analysis of Variance from MINITAB 15.

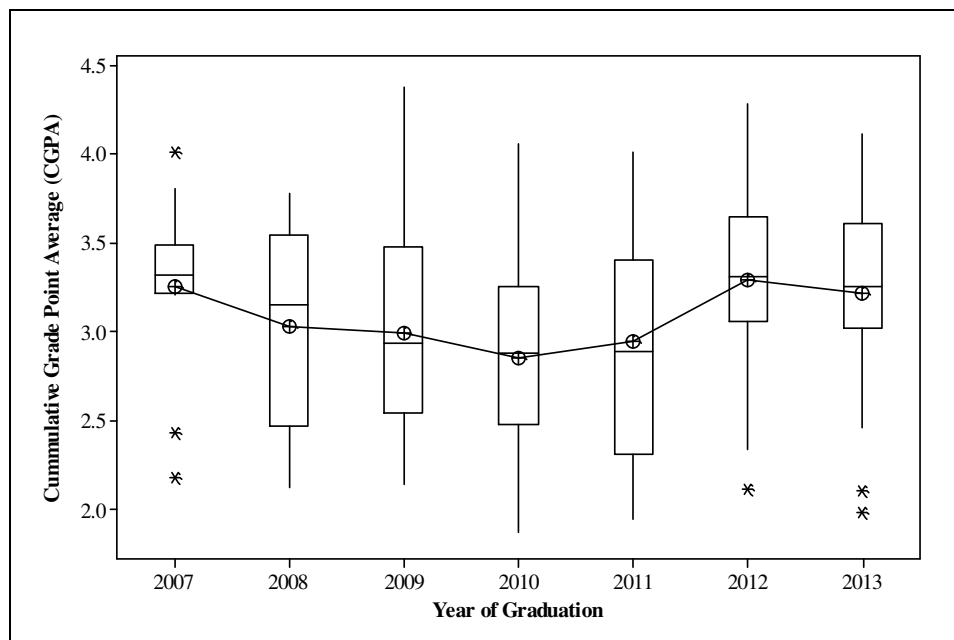


Figure 1: Box-and-Whisker for CGPAs of Graduating Students in Statistics Department from 2007 to 2013

Source	DF	SS	MS	F	P
CGPA	6	4.601	0.767	2.60	0.019
Error	175	51.546	0.295		
Total	181	56.147			

Table 4: One Way Analysis of Variance (ANOVA) for CGPAs of Graduating HND Statistics Students from 2007 to 2013

Table 4 shows the MINITAB output of the One-way Analysis of Variance from the CGPAs. From Table 4, $p = 0.019 < 0.05$. We can therefore conclude that there are significant differences among the years' CGPAs of the HND Statistics graduates. Thus the ANOVA test confirms the revelations by Figure 1 that differences exist among the year group CGPAs.

4.1.2. Strength of Correlation between Students' SSSCE/WASSCE Results and CGPAs in Statistics and Computer Studies Department

This analysis also makes use of the combined data (from 2007 to 2013), which comprises of the SSSCE or WASSCE results and their corresponding CGPAs of all the 182 students who were sampled for the study.

→ Graphical Display of the Correlation between HND Statistics Students' SSSCE/WASSCE Results and CGPAs

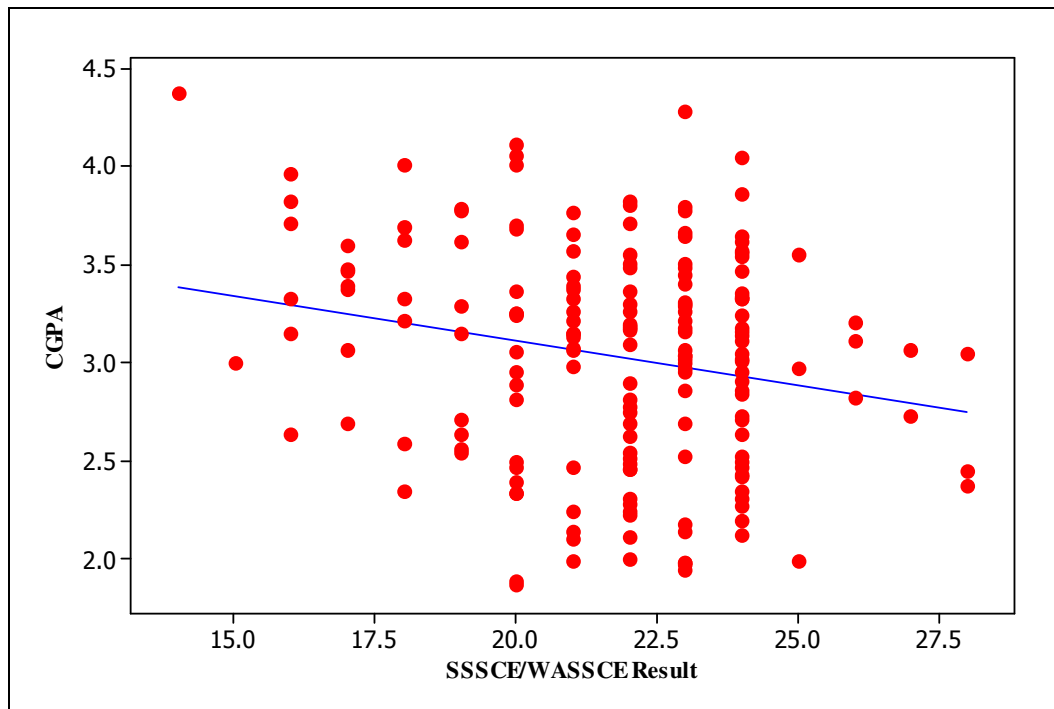


Figure 2: Scatter Plot of Cumulative Grade Point Average (CGPA) on SSSCE/WASSCE Aggregates for 2007 to 2013 HND Statistics Graduating Year Groups

Figure 2 shows the scatterplots of the students' CGPAs on their SSSCE/WASSCE results recorded from 2007 to 2013 in the Mathematics/Statistics and Computer Studies Department. From Figure 8, it is clearly seen that CGPA has a negative linear correlation with SSSCE/WASSCE. Thus on the average, candidates who were admitted with high aggregates ended up with low CGPAs. Similarly, those who were admitted with low aggregates graduated with high CGPAs. The points are also scattered or much deviated from the regression line, indicating weak relationship between the CGPAs and SSSCE/WASSCE results in the Department of Mathematics/Statistics and Computer Studies. The weak correlation between the CGPAs and SSSCE/WASSCE results may be explained by some other influential variables such as the student's background in Mathematics and socio-economic status. Again here, one may observe from the graph that students with the same aggregates had different CGPAs, and these are indicated by several points that are lined up vertically on the graph, contributing to the dispersion.

Apart from possible explanation given to the variability in the data, Taylor and Weir (2012) in the case of the relationship between IELTS and academic achievements, several key intervening variables may also be the cause here, namely, motivation, cultural adjustment, welfare difficulties and some others.

→ b. Pearson’s Correlation Coefficient of HND Statistics Students’ SSSCE/WASSCE Results and CGPAs

Year of Graduation	Pearson’s Correlation Coefficient, <i>r</i>
2007	- 0.460
2008	0.071
2009	- 0.369
2010	- 0.298
2011	-0.297
2012	0.032
2013	- 0.176
Overall	- 0.212

Table 5: Pearson’s Coefficient of Correlation between SSSCE/WASSCE Results and CGPAs of HND Statistics Students over Seven Graduation Years (2007 to 2013)

Table 5 shows the Pearson’s Coefficient of Correlation between the SSSCE/WASSCE results and CGPAs of students from SSS/SHS who had their HND Statistics from year 2007 to 2013. From the table, the strengths of the correlations for the years appear to be different from one another. The strongest correlation is that of the year 2007, $r = - 0.460$, followed by 2009, $r = -0.369$, with the weakest in 2012, a value of $r = 0.032$. One may be expecting all the correlations to be negative, but it is surprising to find those of 2008 and 2012 to be positive. The question is, “Is it natural for a group of students with good SSSCE/WASSCE results to graduate with low CGPA?”. But this happened in 2008 and 2012 in the Department of Mathematics/Statistics and Computer Studies. The overall (combined years) correlation coefficient for the data (graph in Figure 8) is recorded as $r = -0.212$. This value of the Coefficient of Correlation shows a very weak relationship between the SSSCE/WASSCE results and CGPAs, and as mentioned earlier with respect to Figure 8, other suspected influence may be the course.

4.1.3. The Regression Equation for Predicting CGPAs of HND Statistics Students

Table 6 is an extract from MINITAB output of a regression analysis of the data in Appendix 1A, CGPAs on SSSCE/WASSCE results of students who had HND Statistics from the year 2007 to 2013. The regression equation was given as:

$$CGPA = 4.03 - 0.0458X$$

From the equation above, a unit increase in SSSCE/WASSCE aggregate would cause a student’s CGPA to decrease by 0.0458. This regression line shows a negative slope indicating that increasing values of SSSCE/WASSCE aggregates produces decreasing CGPAs and vice versa. Again, one may observe that on the average, students’ CGPAs must be in the range, 2.93 to 3.76, given that the required SSSCE or WASSCE aggregates are normally between 6 and 24.

Predictor	Coef.	SE Coef.	T	P
Constant	4.0307	0.3453	11.67	0.000
SSSCE/WASSCE Agg. (X)	-0.04583	0.01577	- 2.91	0.004

Table 6: Regression of CGPAs on SSSCE/WASSCE Results for Statistics Students over Seven Graduation Years (2007 to 2013)

$$S = 0.545845 \quad R - Sq = 4.5\% \quad R - Sq(adj) = 4.0\%$$

We may now find out if the coefficient of X (SSSCE/WASSCE aggregate) is significant at 0.05 level of significance. From Table 19, $p = 0.000 < 0.05$. Therefore, we conclude that the coefficient of X (SSSCE/WASSCE Aggregate) is significant in the regression equation produced by the HND Statistics students.

4.1.4. Does Mathematics Background Affect the Predictive Validity of SSSCE/WASSCE on CGPAs of HND Statistics Students?

	Pearson’s Combined Data	Correlation Coefficient Without Strong Maths
<i>r</i>	-0.212	- 0.310
<i>n</i>	182	32

Table 7: Pearson’s Correlation Coefficients for Combined Data and Subjects without Strong Math Background

$$r'_1 = (0.5) \log_e \left[\frac{1 + (-0.212)}{1 - (-0.212)} \right] = -0.2153$$

$$r'_2 = (0.5) \log_e \left[\frac{1 + (-0.310)}{1 - (-0.310)} \right] = -0.3205$$

$$Z = \frac{-0.2153 - (-0.3205)}{\sqrt{\frac{1}{182-1} + \frac{1}{32-1}}} = 0.541$$

This has $p = 0.5892$ and is greater than 0.05. This leads to the conclusion at 0.05 significance level that the correlation between SSSCE/WASSCE results and CGPAs for the HND Statistics students with weak Mathematics background is not different from that of the combined data. This appears to be interesting since one may expect some difference. However, we must be mindful of the fact that the result does not necessarily mean that students with weak mathematics background are equally good in academic work, but rather, the regression equation can equally be used to predict their CGPA scores.

4.2. Discussion of Results

The preliminary and further analyses on Table 4 and Figure 1 revealed that yearly results produced by the HND Statistics students in Cape Coast Polytechnic are not the same. Certain years' results are better than the others, and this may come with a number of reasons: among these may be improvement in the polytechnic infrastructure and facilities over the years, change in instructional hands, and the number of needy students found in each year group. Shertzer and Stone (1976) pointed out that financial needs of students are both a major stumbling block and a means of achieving significant gains since the effects are manifested in the social, psychological and perhaps physiological behaviour of students.

The MINITAB output of the correlation between the SSSCE/WASSCE results (aggregates) and CGPAs (see Figure 8) revealed negative correlations. In fact, Pearson's correlation coefficient was $r = -0.212$

The regression equation of the HND Statistics students was $CGPA = 4.03 - 0.0458X$, Hypotheses tests on the coefficient of the random variable X , (SSSCE/WASSCE aggregate) also revealed that this coefficient was significant at 0.05 level of significance.

Lastly, values of the correlation coefficients were changed when students with strong mathematics background were removed from the data (see Table 7), however, hypothesis test revealed that the changes were not significant at 0.05 level of significance.

The next section therefore gives the conclusions on these results.

5. Conclusions and Recommendations

5.1. Conclusions

It must be noted that it is necessary to restrict our conclusions to HND Statistics. However, in all the other polytechnics, the results will be relevant since the same syllabi are used for the HND Statistics Programme, though few deviations may be expected because of possible infrastructural and instructional differences.

The correlation between the SSSCE/WASSCE results (aggregates) and CGPAs is $r = -0.212$ for HND Statistics. Due to the variation in the data, the WASSCE/SSSCE results are not reliable in predicting students' CGPAs.

The regression line that can predict students' CGPA for a given SSSCE/WASSCE aggregate, with very low predictive validity (very low precision) is $CGPA = 4.03 - 0.0458X$.

Values of the correlation coefficients are different when only students with weak mathematics background are admitted. However, the differences are not significant at 0.05 level of significance. Meaning, the same regression model ($CGPA = 4.03 - 0.0458X$) can be used to predict CGPAs of students with weak Mathematics background within the tolerance error limits.

5.2. Recommendations

In view of the above research findings and the conclusions arrived at, the following recommendations were made.

1. The low correlation between the SSSCE/WASSCE aggregates and CGPA means SSSCE/WASSCE has not much influence on the Polytechnic certificates. This may be due to many factors such as discussed by the researchers in the literature. This may include students' previous knowledge about the course, the polytechnic style of focusing on the practical training rather than too much theory, according to the curriculum. Therefore, cut-off points during admissions into HND Statistics may be reviewed for more people to go through the programme.
2. The research revealed that Mathematics alone is not a strong tool to predict the CGPA or success of the candidates, surprising, HND Statistics? Therefore, even though a strong background in Mathematics is important, opportunity should be given to people with as low as grade E (pass) to be on the HND programmes.

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