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Should Schools Be Single Sex? Evidence From Tanzania's ACSE of 2004 To 2009

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Abstract

The article discusses whether advanced secondary education should be single sex or co-educational. The study, of which this article is a product, uses data from Tanzania Advanced Certificate of Secondary Education Results of 2004 to 2009. Observations indicate that there are significant differences in academic performance between single sex and co-educational schools; single sex schools perform better than co-educational schools for both boys and girls. Finally, the same results were obtained when they were segregated by years of study and subject combinations. The study recommends that characteristics which are inherent in single sex schools should be extended to co-educational schools in order to improve the performance of the latter.

1.0 Introduction

Whether secondary schools should be single sex or co-educational has been widely discussed by many educationists and articles on this issue have been widely published (Carpenter & Hayden, 1987; Daly, 1996; Garcia, 1998; Gilson, 2002; Harker, 2000; Lee & Bryk, 1986; Lee & Bryk, 1989; LePore & Wallen, 1996). Wide discussions were held in the 1980s (Sarah, Scott, & Spender, 1980; Shaw, 1980; Steedman, 1985). The debate continued in the early 1990s (Lee & Lockheed, 1990; Lee & Marks, 1990; Riordan, 1990a; Riordan, 1990b; Payne & Newton, 1990; Stables, 1990). They were picked again in mid- 1990s (Riordan, 1994; Marsh & Rowe, 1996; Smith, 1994; Smith, 1996), and late 1990s (Swan, 1998; Streitmatter, 1999) and even 21st century (Spielhofer, O'Donnell, Benton, Schagen, & Schagen, 2002). Some of these studies indicate that single sex schools are better than co-educational schools, while other studies show the opposite (LePore & Wallen, 1996). Unfortunately, many of these studies were not carried out in developing countries.

A number of research studies have been published, which attempt to explain the features and related factors that account for the poor or good performance of students in schools (Atkinson, 2000; Antonio, 2003). This study sought to answer the following three questions.

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(a) Are there any differences between single sex and coeducational schools in terms of academic performance? If there are differences, who are being favoured by these schools?
(b) Is there any relationship between school size (in terms of student numbers) and performance?
(c) Can the results obtained in (i) and (ii) above be replicated when data are separated in different years and different subject combinations?

2.0 Methodology

ACSEE results for 2004 to 2009 were downloaded from the NECTA website. The results were in hypertext mark-up language. The downloaded data contained names of the schools, examination numbers, sex and performance (points, divisions and subjects and their corresponding grades) for each student. The examination year was then added as one of the fields in the data.

The results were converted into an electronic spreadsheet where all incomplete student results in terms of abscondments and withheld results were deleted from the sample. Furthermore, the schools were counted, and in total there were 372 schools. In all the schools, the number of boys and girls was noted; further the percentage of boys and girls in all the schools was calculated. All single sex schools were classified as either boys in a boys' schools or girls in girls' schools. The remaining schools where students from one sex were less than 20%, were removed from the sample. This is because the impact of coeducation on performance was considered to be too small. After this had been done, the total number of schools that remained was 227, with a total of 122,867 students, as shown in Table 1.

Table 1: Research Sample

	Boys' Schools	CoEd Schools	Girls' Schools	Grand Total
Total number of Schools with boys	50	137		187
Total number of Schools with girls		137	40	177
Total number of Boys in the group	25,968	50,035		76,003
Total number of Girls in the group		28,649	18,215	46,864
Minimum number of boys	101	36		36
Minimum number of girls		26	115	26
Maximum number of Boys	1,885	2,576		2,576
Maximum number of Girls		1,277	1,237	1,277

3.0 Data Analysis Techniques

Two main data analysis techniques were adopted in this study - analysis of variance (ANOVA) and chi square tests.

3.1 *Analysis of Variance (ANOVA)*

ANOVA is an extension of a t test for analyzing the reliability of experiments with several numbers of levels on one or more variables. The method compares variance estimates within groups and between groups by using the Fisher test (F-test). F-test is a ratio obtained by dividing between group variance and within group variance. This study used one-way ANOVA (one independent variable). The one-way ANOVA is an analytical technique that requires multiple experiments or readings to be taken from a source that can take two or more different input settings. Then, arithmetical means are compared when one factor is altered. For this study, experiments were in the size of schools. All outputs for one-way ANOVA tests are presented as in Table 2. In one-way ANOVA, the total variation is partitioned into two components.

Table 2 ANOVA Results Presentation Style

Variable	Source of variations	Sum of Squires	Degrees of freedom	Mean Squire	F values	Significance level
	Between Levels	SS_L	df_L	MS_L	$F_0 = \frac{MS_L}{MS_E}$	
	Error (within levels)	SS_E	df_E	MS_E		
	Total	SS_T	df_T			

Where

Variable is school types

SS_L the sum of squares due to levels

SS_E the sum of squares due to errors

SS_T the total sum of squares

df_L degrees of freedom associated with levels

df_E degrees of freedom associated with errors

df_T total degrees of freedom

MS_L mean squares from levels

MS_E mean squares from errors

F_0 value that follows Fisher distribution degrees of freedoms df_L and df_E

Significance level – Significance indicates the significance level of the F-test.

3.2 *Measures of Association: Chi Square and Contingency Tables*

Measures of association for normal data do not depend on the particular order in which categories are listed. These are several measures of association; however, most of them depend on the chi square statistic. Liebetrau summarizes the main common measures of association (Liebetrau, 1976). For more details of these measures the reader is asked to consult the book, as the mathematical knowledge required is beyond the scope of this paper. Some of the measures are Pearson's coefficient of mean square, Pearson's Contingency Coefficient and Sakoda Modification, and Tschuprow's Contingency Coefficient. Generally, the chi-square test statistic checks

whether the two data sets are related, that is associated. This means that after knowing one characteristic one can know the second one. This is also known as the test of independence, whereby two data sets are independent of one another.

Other measures of association are Goodman-Kruskal λ and Goodman Kruskal τ (for measuring the relative usefulness of one variable in predicting the other variable), Cohen's κ; Weighted κ; and Coleman-Light Measures of conditional agreements (measures of agreements). This study did not use these statistics due to their characteristics and these are just extensions of the chi-square statistic.

A chi-square requires a chi statistic in order to be calculated from observed and expected variables in a contingency table. The research presents only tables of observed results and their respective chi statistic, degree of freedom and significance levels.

There are two ways to check whether or not conclusions made drawn from the chi-square should be interpreted. These are based on the minimum value in each cell. One argument is that all values in each cell in a contingency table should be greater than 5. The second line of thought is that all values in the contingency table should have an expected value greater than one for each cell when either of the number of rows or columns is two (Everett, 1977; Slakter, 1966; Lewontin & Felsentein, 1965). This study presents both values; if any of the values are not met, the test is discarded.

A major weakness of the chi-square test is its dependence on sample size. If the sample is too small chances of failing to reject the null hypotheses increase. On the other hand, if the sample is too big, chances of always accepting competing (alternative) hypotheses increase. There are several modifications proposed in order to rectify this problem (Joreskog & Sörbom, 1982). As the sample size for this study was large the hypotheses were set in such a way that when accepting competing hypotheses, further analyses were performed.

3.3 *Research Questions*

3.3.1 *Is there any difference between the performance in different school types?*

First and foremost, the study wanted to know whether the four groups had the same averages. An ANOVA test was conducted based on the descriptive statistics generated. The ANOVA results are displayed in Table 3. From the table, at 0.000 significance level, the samples do not have the same means. This is an indicator that performance differs from one type of school to another. In the NECTA system, the lower points indicate good performance. Division one starts from 3 to 9 points. In both cases, the number of low points was better in single sex schools than in coeducational schools.

Table 3: Descriptive Performance of Different Groups and ANOVA Tests

School type	N	Minimum	Maximum	Mean	Std. Deviation
Boys in Boys' Schools	25968	3	21	12.788	3.859
Boys in Coeducational Schools	50035	3	21	13.817	3.596
Girls in Girls' Schools	18215	3	21	12.883	3.657
Girls in Coeducational Schools	28649	3	21	14.142	3.497

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	36774.4	3	12258.124	925.376	.000
Within Groups	1627521.3	122863	13.247		
Total	1664295.6	122866			

Source: Data Analysis (2009)

From Table 3, boys performed better in single sex schools than in coeducational ones. The same trend is observed for girls. In single sex schools, boys outperformed girls by 0.1; while in coeducational schools, boys outperformed girls by almost 0.3. This implies that girls are more disadvantaged in coeducational schools than boys. Furthermore, the differences in points for boys in single sex and coeducational schools is 1.1 in favour of single sex schools, while for girls in single sex schools and coeducational schools, the difference is 1.2 in favour of single sex schools. Therefore, coeducational schools impact negatively on both boys and girls, although, girls are affected more negatively than boys.

3.3.2 Is there any relationship between school type and performance?

In order to answer this question, the type of school was cross-tabulated with performance of students. Table 4 presents the results of cross-tabulation; it indicates that there is nearly twice as much chance of getting division 1 (good performance) by both girls and boys in single sex schools than in coeducational ones (from probabilities).

If one compares division 1 and failed division for both categories, for every one student who fails, for single sex schools there are about two students who obtained division 1; while for coeducational schools, there are more than five. While the performance of boys and girls is nearly the same in single sex schools in terms of ratio between division 1 and fail, coeducational schools seem to disadvantage girls more than boys.

To ascertain whether or not there is any association between school type and performance, a chi-square test was performed. The results indicate that there is association between the type of school a student attends and performance (Table 4).

Table 4: Cross Tabulation of School Type and Performance

	Division						Ratio Div 1 to Div Failed
	I	II	III	IV	FLD	Total	
Boys in Boys' Schools	5,375	6,602	9,687	3,286	1,018	25,968	
Boys in Coeducational Schools	5,998	12,076	21,152	7,621	3,188	50,035	
Girls in Girls' Schools	3,463	5,019	6,877	2,192	664	18,215	
Girls in Coeducational Schools	2,801	6,457	12,536	4,902	1,953	28,649	
	17,637	30,154	50,252	18,001	6,823	122,867	
Boys in Boys' Schools	20.70%	25.42%	37.30%	12.65%	3.92%	100.00%	5.28
Boys in Coeducational Schools	11.99%	24.14%	42.27%	15.23%	6.37%	100.00%	1.88
Girls in Girls' Schools	19.01%	27.55%	37.75%	12.03%	3.65%	100.00%	5.21
Girls in Coeducational Schools	9.78%	22.54%	43.76%	17.11%	6.82%	100.00%	1.43

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2621.537(a)	12	.000
Likelihood Ratio	2598.631	12	.000
N of Valid Cases	122867		

Note: (a) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 1011.51.

Source: Data Analysis (2009)

3.3.3 Can the same results be obtained if data is segregated by year of study?

This research question was tested by doing a separate analysis for each year of the 2004 to 2009 results. Table 5 gives the cross-tabulation of these results; and from this table, some trends are replicated. Table 6 indicates that there is association between the two variables under consideration, even if separated by years.

Table 5: Cross Tabulation of School Type and Performance Segregated by Year

Year		Division					
		I	II	III	IV	FLD	Total
2004	Boys in Boys' Schools	811	805	768	105	35	2524
	Boys in Coeducational Schools	1205	1553	1645	384	105	4892
	Girls in Girls' Schools	614	613	441	63	18	1749
	Girls in Coeducational Schools	477	799	884	221	51	2432
		3107	**3770**	**3738**	**773**	**209**	**11597**
2005	Boys in Boys' Schools	840	836	1151	181	39	3047
	Boys in Coeducational Schools	994	1726	2496	626	255	6097
	Girls in Girls' Schools	561	663	548	61	10	1843
	Girls in Coeducational Schools	500	956	1405	378	133	3372
		2895	**4181**	**5600**	**1246**	**437**	**14359**

2006	Boys in Boys' Schools	1030	1147	1091	228	52	3548
	Boys in Coeducational Schools	992	2330	2998	864	362	7546
	Girls in Girls' Schools	631	873	728	121	28	2381
	Girls in Coeducational Schools	548	1271	1744	492	199	4254
		3201	**5621**	**6561**	**1705**	**641**	**17729**
2007	Boys in Boys' Schools	575	1011	2101	1258	371	5316
	Boys in Coeducational Schools	569	1571	3635	1963	730	8468
	Girls in Girls' Schools	325	702	1457	731	202	3417
	Girls in Coeducational Schools	216	725	2232	1428	555	5156
		1685	**4009**	**9425**	**5380**	**1858**	**22357**
2008	Boys in Boys' Schools	973	1399	2071	1006	324	5773
	Boys in Coeducational Schools	925	2285	4283	2168	885	10546
	Girls in Girls' Schools	597	985	1540	762	223	4107
	Girls in Coeducational Schools	415	1239	2512	1390	501	6057
		2910	**5908**	**10406**	**5326**	**1933**	**26483**
2009	Boys in Boys' Schools	1146	1404	2505	508	197	5760
	Boys in Coeducational Schools	1313	2611	6095	1616	851	12486
	Girls in Girls' Schools	735	1183	2163	454	183	4718
	Girls in Coeducational Schools	645	1467	3759	993	514	7378
		3839	**6665**	**14522**	**3571**	**1745**	**30342**

Source: Data Analysis (2009)

Table 6: Chi-Square Tests of Cross-Tabulation of School Type and Performance Segregated by Year

Year		Value	Df	Asymp. Sig. (2-sided)
2004	Pearson Chi-Square	269.703(a)	12	.000
	Likelihood Ratio	277.675	12	.000
	N of Valid Cases	11597		
2005	Pearson Chi-Square	594.765(b)	12	.000
	Likelihood Ratio	626.757	12	.000
	N of Valid Cases	14359		
2006	Pearson Chi-Square	875.762(c)	12	.000
	Likelihood Ratio	883.147	12	.000
	N of Valid Cases	17729		
2007	Pearson Chi-Square	365.625(d)	12	.000
	Likelihood Ratio	372.476	12	.000
	N of Valid Cases	22357		
2008	Pearson Chi-Square	546.116(e)	12	.000
	Likelihood Ratio	537.501	12	.000
	N of Valid Cases	26483		
2009	Pearson Chi-Square	726.218(f)	12	.000
	Likelihood Ratio	716.095	12	.000
	N of Valid Cases	30342		

Notes: (a) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 31.52.
(b) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 56.09.
(c) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 86.09.
(d) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 257.53.
(e) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 299.77.
(f) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 271.34.

Source: Data Analysis

3.3.4 Does it matter if data is separated based on subjects studied?

All subject combinations with more than 5,000 students were considered for analysis. From this analysis nine subject combinations were considered: Basic Applied Mathematics, Economics, Commerce and Accountancy subject combinations (BECA); Geography, Advanced Mathematics and Economics subject combinations (GAE); Geography, Chemistry, Biology and Basic Applied Mathematics subject combinations (GCBB); History, Geography, Basic Applied Mathematics and Economics subject combinations (HGBE); History, Geography and English language subject combinations (HGE); History, Geography and Kiswahili subject combinations (HGK); History, Kiswahili and English Language subject combinations (HKE); Physics, Chemistry and Advanced Mathematics subject combinations (PCA) as well as Physics, Chemistry and Biology and Basic Applied Mathematics subject combinations (PCBB).

Table 7 provides data segregated by subject combinations. Candidates from single sex schools generally performed better than those in coeducational schools. Moreover, the ratio of those scoring division one to those who failed was higher for single sex schools than for coeducational schools. This is further indicator that students in higher secondary education perform better in single sex schools

Table 7: Cross Tabulation of Type of School and Performance Segregated by Subject Combinations

Subject comb.		Division						Ratio Div 1 to Failed
		I	*II*	*III*	*IV*	*FLD*	*Total*	
PCM	Boys in Boys' Schools	1,186	1,041	2,380	1,076	437	6,120	2.71
	Boys in Coeducational Schools	330	484	1,480	762	599	3,655	0.55
	Girls in Girls' Schools	195	224	441	212	119	1,191	1.64
	Girls in Coeducational Schools	48	86	462	330	268	1,194	0.18
		1,759	**1,835**	**4,763**	**2,380**	**1,423**	**12,160**	**1.24**
PCBB	Boys in Boys' Schools	624	994	2,280	958	331	5,187	1.89
	Boys in Coeducational Schools	147	332	1,177	693	429	2,778	0.34
	Girls in Girls' Schools	172	348	883	460	161	2,024	1.07
	Girls in Coeducational Schools	76	190	776	432	238	1,712	0.32
		1,019	**1,864**	**5,116**	**2,543**	**1,159**	**11,701**	**0.88**
GCBB	Boys in Boys' Schools	44	265	643	249	40	1,241	1.1
	Boys in Coeducational Schools	16	129	833	516	260	1,754	0.06
	Girls in Girls' Schools	37	165	636	394	123	1,355	0.3
	Girls in Coeducational Schools	7	78	611	502	272	1,470	0.03
		104	**637**	**2,723**	**1,661**	**695**	**5,820**	**0.15**
BECA	Boys in Boys' Schools	232	208	154	18	1	613	232
	Boys in Coeducational Schools	217	682	1,379	610	307	3,195	0.71
	Girls in Girls' Schools	43	134	213	35	15	440	2.87
	Girls in Coeducational Schools	126	388	949	444	237	2,144	0.53
		618	**1,412**	**2,695**	**1,107**	**560**	**6,392**	**1.1**

Subject Comb		Division						Ratio Div 1 to Failed
		I	II	III	IV	FLD	Total	
GME	Boys in Boys' Schools	318	605	768	130	16	1,837	19.88
	Boys in Coeducational Schools	249	687	1,995	921	357	4,209	0.7
	Girls in Girls' Schools	112	264	403	90	12	881	9.33
	Girls in Coeducational Schools	81	277	693	264	90	1,405	0.9
		760	**1,833**	**3,859**	**1,405**	**475**	**8,332**	**1.6**
HGBE	Boys in Boys' Schools	319	563	488	69	8	1,447	39.88
	Boys in Coeducational Schools	590	1,465	2,188	532	176	4,951	3.35
	Girls in Girls' Schools	169	304	299	47	14	833	12.07
	Girls in Coeducational Schools	215	506	734	226	85	1,766	2.53
		1,293	**2,838**	**3,709**	**874**	**283**	**8,997**	**4.57**
HGK	Boys in Boys' Schools	420	426	364	38	4	1,252	105
	Boys in Coeducational Schools	995	1,970	2,706	687	144	6,502	6.91
	Girls in Girls' Schools	406	607	721	147	29	1,910	14
	Girls in Coeducational Schools	349	818	1,197	350	80	2,794	4.36
		2,170	**3,821**	**4,988**	**1,222**	**257**	**12,458**	**8.44**
HGL	Boys in Boys' Schools	1,106	1,271	916	128	25	3,446	44.24
	Boys in Coeducational Schools	1,103	2,526	3,413	981	285	8,308	3.87
	Girls in Girls' Schools	565	879	1,136	241	39	2,860	14.49
	Girls in Coeducational Schools	381	1,132	1,852	609	179	4,153	2.13
		3,155	**5,808**	**7,317**	**1,959**	**528**	**18,767**	**5.98**
HKL	Boys in Boys' Schools	1,126	1,229	1,694	620	156	4,825	7.22
	Boys in Coeducational Schools	2,351	3,801	5,981	1,919	631	14,683	3.73
	Girls in Girls' Schools	1,764	2,094	2,145	566	152	6,721	11.61
	Girls in Coeducational Schools	1,518	2,982	5,262	1,745	504	12,011	3.01
		6,759	**10,106**	**15,082**	**4,850**	**1,443**	**38,240**	**4.68**

Source: Data Analysis

In order to find out whether or not there is any association between performance and type of school, chi-square tests were conducted for all combinations. All of them confirmed that there is association at 0.000 degree of significance (Table 8). The results for BECA and HGK should be cautiously interpreted as some cells have less than 5.

Table 8: Chi Square Tests for Cross Tabulation of Type of School and Performance Segregated by Subject Combinations

		Value	df	Asymp. Sig. (2-sided)
PCM	Pearson Chi-Square	711.642(a)	12	.000
	Likelihood Ratio	741.528	12	.000
	N of Valid Cases	12160		
PCBB	Pearson Chi-Square	465.505(b)	12	.000
	Likelihood Ratio	470.579	12	.000
	N of Valid Cases	11701		

		Value	df	Asymp. Sig. (2-sided)
GCBB	Pearson Chi-Square	454.980(c)	12	.000
	Likelihood Ratio	470.266	12	.000
	N of Valid Cases	5820		
BECA	Pearson Chi-Square	878.192(d)	12	.000
	Likelihood Ratio	764.862	12	.000
	N of Valid Cases	6392		
GME	Pearson Chi-Square	770.442(e)	12	.000
	Likelihood Ratio	815.843	12	.000
	N of Valid Cases	8332		
HGBE	Pearson Chi-Square	312.620(f)	12	.000
	Likelihood Ratio	327.518	12	.000
	N of Valid Cases	8997		
HGK	Pearson Chi-Square	438.511(g)	12	.000
	Likelihood Ratio	436.324	12	.000
	N of Valid Cases	12458		
HGL	Pearson Chi-Square	1302.383(h)	12	.000
	Likelihood Ratio	1311.700	12	.000
	N of Valid Cases	18767		
HKL	Pearson Chi-Square	1008.985(i)	12	.000
	Likelihood Ratio	1004.990	12	.000
	N of Valid Cases	38240		

Notes:

(a) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 139.37.
(b) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 149.09.
(c) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 22.18.
(d) 1 cells (5%) have an expected count of less than 5. The minimum expected count is 38.55.
(e) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 50.23.
(f) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 26.20.
(g) 5 cells (5%) have an expected count of less than 5. The minimum expected count is 25.83.
(h) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 80.46.
(i) 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 182.07.

Source: Data Analysis (2009)

4.0 Conclusions and Recommendations

The detailed analysis of ACSE results based on more than 120,000 students in six years, 2004 to 2009, provides useful insights on how good or bad students perform depending on the type of school. The conclusions are summarized below.

(a) There is strong evidence that there are differences in the level of performance among boys and girls based on the school where they study – whether singles sex or coeducational.

(b) In both cases, boys and girls perform better in single sex schools than in coeducational schools. However, coeducational schools impact more negatively on girls than boys.
(c) The same results are obtained when results are segregated by year of study and subject combinations, except for a few business-based subjects.

Based on above conclusions, the following recommendations are proposed:
(a) Generally, for high impact performance, it is important to have single sex schools and not coeducational ones for both boys and girls.
(b) There are some characteristics/activities in single sex schools that increase their performance. These should be emulated in coeducational schools in order to increase their performance (this assumes that single sex schools may not be feasible is some areas).

5.0 Study Limitations

It is important for this study to discuss some of its limitations. There are two main limitations on interpreting these data and results. These are seminary school performance as well as extending results to lower schools and colleges.

Seminaries are normally single sex schools. These schools not only teach academic subjects, but also inculcate a certain culture based on the religion it propagates. These other factors could also influence the performance of students rather than the type of school.

This analysis was done amongst advanced secondary students. Anecdotal evidence tends to show that students pass this level at at average age of 19 to 21. Most of the students at these ages start to experience their freedom from bondage to their parents and try to explore a lot of activities. Their performance is therefore affected by lifestyle changes. This implies that one has to also take this into considerations when attempting to extrapolate data to lower secondary schools as well as college life.

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