A Study of Performance of Teacher and Non-Teacher Streams Graduates with Reference to Natural Sciences II: A Test about the Dispersion

Eshetu Wencheko*

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Introduction

Addis Ababa University has been running and still runs undergraduate non-teacher and teacher programmes in subject areas of the natural sciences at the Faculty of Science. After completing the freshman year in the Faculty, students join the various disciplines including Pharmacy, Medicine, Veterinary Medicine, Engineering, Geology, Statistics, Biology, Chemistry, Mathematics and Physics. The last four subject areas form the group of natural sciences. Students who take these subjects as their major area are further classified as teacher and non-teacher programme students.

While the former programme trains personnel who will be absorbed in non-teaching sectors of the society, the latter caters for training science teachers for high schools in the four subject areas mentioned above.

The streamlining of students into these two programmes is based on academic overall achievement during the two semesters of the

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freshman year. Those who join the teacher stream are, in relative terms, low achievers, as far as their cumulative first year grades are concerned, when compared with those who join the non-teacher streams. During the three years of study in the Faculty the courses in major and minor areas given to both groups overlap to a great extent. An empirical study by Eshetu (1998) showed that there was no significant difference in the average performance of four batches of graduates. A non-parametric location test called the *Wilcoxon-Two-Sample Test* about the median provided empirical evidence about the non-existence of a significant difference in performance both in the major areas as well as in overall achievement. That was invariably true for four batches of graduates who graduated in July 1995, 1996, 1997 and 1998.

For the purpose of the empirical investigation the overall Cumulative Grade-Point Average (CGPA) and the major CGPA (MGPA) of the four batches were considered. These data were obtained from the Office of the Registrar, Addis Ababa University. The number of graduates of both programmes are given in the first two tables in the Appendix.

However, the absence of significant difference in performance, as the former study established, does not mean that the possibility of prevalence in the dispersion of the distribution of grades can be ruled out. This matter is worth paying attention to, and, therefore, the present study is an attempt to provide empirical evidence about the question of heterogeneity in achievement. In this study we use the same data that was gathered for a previous study.

Methodology

The statistical analysis of the data and the interpretation of the results of the analysis are based on a non-parametric (also known as distribution-free) statistical method that relies on rank theory. A two-sample rank test known as the *Siegel-Tukey Test* (Siegel and Tukey, 1960) is used in the analysis. The test establishes whether there is a

difference in the dispersion of the distribution of grades of prospective teachers and non-teacher categories.

Formulation of the Statistical Problem

Assumptions: Suppose that the variables **X** and **Y** stand for grades (CGPA or MCGPA) of non-teacher and teacher stream graduates, respectively. Furthermore, assume that **X** and **Y** have unknown continuous distributions **F** and **G** as having the same median but they manifest a difference in the scatter of grades. In addition to these, assume that the samples we obtain from **X** and **Y** are independent. In this study since we are dealing with all grades we do not talk about samples, and hence, the totality of all grades are used in the study.

The statistical problem: The non-parametric test is given by

> H_0: $G(z) = F(z)$ versus H_1: $G(z) = F(\delta z)$ for all real numbers z and for some positive constant $\delta \neq 1$.

The above formulation will be understood as follows: we assert that the distributions ***F*** and ***G*** of grades do not differ in their dispersion/scatter. This stipulation about the equality of the two distributions ***F*** and ***G*** is referred to as the null-hypothesis, and is designated by H_0: $G(z) = F(z)$. On the other hand, the context that underscores the existence of a difference in variability of the two distributions is called the alternative hypothesis, H_1.

The technical steps we follow in testing the hypothesis:

Pooling the data: Suppose there are *m* observations from **X** and *n* observations from **Y**. Denote these by $x_1, x_2, \ldots, x_m$ and $y_1, y_2, \ldots, y_n$. Combine the two samples, and then assign them ranks. This means, the values of the sample observations in the pooled sample of size $m + n$ will be arranged according to their magnitude from smallest to largest. The smallest will be assigned rank 1, the second smallest will get rank 2, and so forth, and the largest will be assigned rank $m + n$. If

there are ties, that is, there are two or more observations of equal size, then average ranks will be assigned to the observation in each tied group. In a second stage, we apply a rank assignment procedure following Siegel and Tukey (1960) (see also Gibbons and Chakraborti, 1992; Siegel and Castellan, 1988).

Construction of the test statistic: Take the sum of the ranks of the **X** variable that have been obtained after the Siegel-Tukey rank assignment procedure. Because this could take any possible value, we cannot definitely foretell what its value could be; it is regarded as an unpredictable quantity that is referred to as a *random variable*. A random variable used in hypothesis testing, is called a *test statistic*. In testing a hypothesis the value which a test statistic takes (based on the sample observations) is used as a yardstick to check if the null-hypothesis cannot be rejected with a high degree of sureness or probability. Normally, in statistical tests the most commonly used probabilities of sureness are as high as 90%, 95% and 99%.

A comparison of the Siegel-Tukey ranks with tabulated values leads to a decision. The tabulated values vary depending on the values *m* and *n*, and the so-called *level of significance* of the test. We denote a level of significance by the Greek letter α. In testing statistical hypotheses the levels of significance have to be set a priori for the sake of fairness. If 90%, 95% or 99% certainty is sought, then the corresponding levels of significance are α = 10%, 5 % or 1%. Usually α is given in decimals as 0.1, 0.05 or 0.01.

The decision rules: Suppose we agree that the sum $m + n$ is N, which is now the size of the pooled sample. Let $\mathbf{S_N}$ stand for the statistic representing the sum of the ranks of the *x*-values in the larger pooled sample of size N. Without loss of generality, we assume that *m* is at most equal to *n*.

Before we give the appropriate decision rules we make a distinction between what are called small-sample and large-sample properties, because the decision concerning rejection or non-rejection depends

on the size of the samples. Small samples are samples where m and/or n are/is not larger than 25; the cases where m and/or n are/is greater than 25 are considered as large. We employ the following two decision rules to reach decisions in small and large samples cases.

Test Rule 1 (small-sample case):

Reject $\boldsymbol{H}_0$ if $s_N(m, n) \geq s(m, n; 1-\alpha/2)$ or
$s_N(m, n) \leq s(m, n; \alpha/2)$; otherwise do not reject $\boldsymbol{H}_0$.

Test Rule 2 (large-sample case):

Reject $\boldsymbol{H}_0$ if $|z_N| \geq z(1-\alpha/2)$; otherwise do not reject $\boldsymbol{H}_0$.

In the above expressions: $s_N(m, n)$ represents the computed value of S_N for given m and n, while $s(m, n; \alpha/2)$ is a value that is available in Tables. The other quantity $s(m, n; 1-\alpha/2) = m(N+1) - s(m, n; \alpha/2)$.

On the other hand, z_N stands for the computed value of the standardised $\mathbf{S_N}$ given by

$$Z_N = [S_N - E(S_N)]/s.d.(S_N).$$

For the sake of easy usage, we point out that the mean $E(\mathbf{S_N})$ and variance $Var(\mathbf{S_N})$ of $\mathbf{S_N}$ are simply functions of m and n, and in the absence of ties these are simply

$$E(\mathbf{S_N}) = m(N+1)/2 \qquad Var(\mathbf{S_N}) = mn(N+1)/12.$$

The term $s.d.(\mathbf{S_N})$ in the expression for S_N is the square root of the variance, which is the standard deviation of $\mathbf{S_N}$.

We would like to remark that the value of $E(\mathbf{S_N})$ remains unchanged in the presence of ties. This, however, does not hold for the variance; the variance can very easily be obtained by using a result due to Lehmann (1975).

The Results and Interpretation

Below are given comparisons of computed values of S_N, which are given as $s_N(m, n)$ and values of $s(m, n; \alpha/2)$ and $s(m, n; 1-\alpha/2)$ at $\alpha = 0.05$. The z_N-values are compared with $z(0.975)$.

A. For the graduates of July 1995:

Overall CGPA

Biology $s_{20} = 104$; $s(10, 10; 0.025) = 78 < 104$; $s(10, 10; 0.975) = 132 > 104$

Chemistry $s_{30} = 231$; $s(12, 18; 0.025) = 138 < 231$; $s(12, 18; 0.975) = 234 > 231$

Mathematics $s_{33} = 142.5$; $s(9, 24; 0.025) = 104 < 142.5$; $s(9, 24; 0.975) = 212 > 142.5$

Physics $s_{23} = 80$; $s(7, 16; 0.025) = 54 < 80$; $s(7, 16; 0.975) = 114 > 80$

Major CGPA

Biology $s_{20} = 116$; $s(10, 10; 0.025) = 78 < 116$; $s(10, 10; 0.975) = 132 > 116$

Chemistry $s_{30} = 187$; $s(12, 18; 0.025) = 138 < 187$; $s(12, 18; 0.975) = 234 > 187$

Mathematics $s_{33} = 114.5$; $s(9, 24; 0.025) = 104 < 114.5$; $s(9, 24; 0.975) = 212 > 114.5$

Physics $s_{23} = 74$; $s(7, 16; 0.025) = 54 < 74$; $s(7, 16; 0.975) = 114 > 74$

B. For the graduates of July 1996:

Overall CGPA

Biology $s_{15} = 28$; $s(5, 10; 0.025) = 23 < 28$; $s(5, 10; 0.975) = 57 > 28$

Chemistry $s_{19} = 46$; $s(7, 12; 0.025) = 46 = 46$; $s(7, 12; 0.975) = 94 > 46$

Mathematics $s_{17} = 26$; $s(3, 14; 0.025) = 11 < 26$; $s(3, 4; 0.975) = 43 > 26$

Physics $s_{12} = 25$; $s(4, 8; 0.025) = 14 < 25$; $s(4, 8; 0.975) = 38 > 25$

Major CGPA

Biology $s_{15} = 32$; $s(5, 10; 0.025) = 23 < 32$; $s(5, 10; 0.975) = 57 > 32$

Chemistry $s_{19} = 57.5$; $s(7, 12; 0.025) = 46 < 57.5$; $s(7, 12; 0.975) = 94 > 57.5$

Mathematics $s_{17} = 34$; $s(3, 14; 0.025) = 11 < 34$; $s(3, 4; 0.975) = 43 > 34$

Physics $s_{12} = 20$; $s(4, 8; 0.025) = 14 < 20$; $s(4, 8; 0.975) = 38 > 20$

C. For the graduates of July 1997:

Overall CGPA

Biology $s_{43} = 184.5$; $z_{43} = -0.5701 < 1.96 = z(0.975)$**

Chemistry $s_{21} = 78$; $s(7, 14; 0.025) = 50 < 78$; $s(7, 14; 0.975) = 104 > 78$

Mathematics $s_{46} = 238.5$; $z_{46} = 1.4633 < 1.96 = z(0.975)$**

Physics $s_{14} = 31$; $s(5, 9; 0.025) = 22 < 31$; $s(5, 9; 0.975) = 53 > 31$

Major CGPA

Biology $s_{43} = 210.5$; $z_{43} = 0.5279 < 1.96 = z(0.975)$**

Chemistry $s_{21} = 73$; $s(7, 14; 0.025) = 50 < 73$; $s(7, 14; 0.975) = 104 > 73$

Mathematics $s_{46} = 203$; $z_{46} = 0.4344 < 1.96 = z(0.975)$**

Physics $s_{14} = 39$; $s(5, 9; 0.025) = 22 < 39$; $s(5, 9; 0.975) = 53 > 39$

D. For the graduates of July 1998:

Overall CGPA

Biology $s_{37} = 244$; $s(13, 24; 0.025) = 185 < 244$; $s(13, 24; 0.975) = 309 > 244$

Chemistry $s_{19} = 63$; $s(7, 12; 0.025) = 46 < 63$; $s(7, 12; 0.975) = 94 > 63$

Mathematics $s_{53} = 268$; $z_{53} = -0.0455 < 1.96 = z(0.975)$**

Physics $s_{24} = 98.5$; $s(9, 15, 0.025) = 79 < 98.5$; $s(9, 15; 0.975) = 132 > 98.5$

Major CGPA

Biology $s_{37} = 234.5$; $s(13, 24; 0.025) = 185 < 234.5$; $s(13, 24; 0.975) = 309 > 234.5$

Chemistry $s_{19} = 55.5$; $s(7, 12; 0.025) = 46 < 55.5$; $s(7, 12; 0.975) = 94 < 55.5$

Mathematics $s_{53} = 308.5$; $z_{53} = 0.8752 < 1.96 = z(0.975)$**

Physics $s_{24} = 128$; $w(9, 15; 0.025) = 79 < 128$; $s(9, 15; 0.975) = 146 > 128$

The numerical results with double asterisk were obtained using the normal approximation. These as well as those obtained according to Test Rule 1 confirm that with 95% confidence we cannot reject the assertion which states that there are no differences in the dispersion of grades both in overall performance as well as in performance in the major subject area.

Conclusion

The results of the study confirmed the absence of disparity in the grade distributions for all batches of graduates in each of the subject areas. Earlier findings of an empirical study by Eshetu (1998) showed that the teacher and non-teacher streams in all four subject areas performed equally well. The results of the two empirical studies, therefore, lead to the conclusion that performance as measured by CGPA and MGPA of graduates of non-teacher and teacher streams in the natural sciences are very alike.

This indicates that the procedure of induction which is biased against would-be teachers did not have an impact on their performance at the stage of exit.

References

Eshetu Wencheko (1998) *A Study of Performance of Teacher and Non-Teacher Streams Graduates with Reference to Natural Sciences I: A Test about the Location.* ***The*** **Ethiopian Journal of Education, 18(2) 1-17**.

Gibbons, J.D. and Chakraborti, S. (1992). **Nonparametric Statistical Inference** *(3rd ed.)*. New York, Marcel Dekker, Inc.

Lehmann, E. L. (1975). **Nonparametrics: Statistical Methods Based on Ranks.** San Francisco, Holden-Day.

Siegel, S. and Tukey, J.W. (1960). *A Nonparametric Sum of Ranks Procedure for Relative Spread in Unpaired Samples.* **Journal of the American Statistical Association** 55, 429-445; correction, ibid., 56, 1005 (1961).

Siegel, S. and Castellan, N.J. (1988). **Nonparametric Statistics for Behavioural Sciences** (2nd ed.). New York, McGraw-Hill Book Company.

Appendix

Table 1: Number of Graduates by Stream, Subject Area and Year

Non-Teacher Streams:

Subject	1995	1996	1997	1998	Total
Biology	10	10	9	13	42
Chemistry	12	7	7	7	33
Math	9	3	8	10	30
Physics	7	4	5	9	25
Total	38	24	29	39	130

Teacher Streams:

Subject	1995	1996	1997	1998	Total
Biology	10	5	34	24	73
Chemistry	18	12	14	12	56
Math	24	14	38	43	119
Physics	16	8	9	15	48
Total	68	39	95	94	296

Table 2: MGPA and Overall CGPA of Graduates by Stream, Subject area and Year of Graduation (all in July of the Indicated Years). The Ranking Follows the Procedure of Rank Assignment According to Siegel and Tukey.

1995 Graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.13	10	2.64	19	2.36	9	2.28	4
2.89	20	2.49	17	2.22	4	2.32	9
2.34	8	2.33	13	2.63	17	2.28	5
3.03	15	2.77	10	2.15	1	2.32	12
2.46	12	2.29	8	3.08	11	2.75	14
3.92	2	3.65	2	3.33	6	3.08	6
3.22	7	2.86	7	3.54	3	3.26	3
2.91	19	2.71	15	2.56	13	2.68	18
2.29	5	2.21	1	2.57	16	2.47	16
2.97	18	2.77	11	3.04	14	2.59	20
Rank sum	46		104		94		116

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.69	14	2.46	23	2.33	29	2.28	24
2.30	28	2.19	14.5	2.89	8.5	2.82	6
2.43	27	2.35	30	2.00	4.5	2.12	4.5
2.12	21	2.21	17	2.00	4.5	2.16	10.5
3.00	6	2.66	11	2.10	18.5	2.12	4.5
2.68	15	2.49	22	2.41	30	2.79	7
2.71	11	2.56	18	2.23	25	2.26	21
2.52	19	2.34	28.5	2.89	8.5	2.94	3
3.27	2	3.09	2	2.14	24	2.19	14.5
2.64	18	2.45	26	2.09	16	2.16	10.5
3.03	3	2.63	14	2.00	4.5	2.00	1
2.48	23	2.31	25	2.44	26	2.75	10
				2.49	22	2.56	17
				2.00	4.5	2.56	17
				2.04	12	2.34	28.5
				2.02	9	2.14	8
				2.10	18.5	2.41	27
				2.08	13	2.24	20
Rank sum	187		231		278		234

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
02.40	22	2.51	18	2.00	4.5	2.29	18.5
2.13	17	2.35	24	2.00	4.5	2.18	10.5
3.41	1	3.20	2	2.23	24.5	2.42	30
2.47	15	2.35	25	2.44	18.5	2.58	14.5
2.70	10	2.49	26	2.08	12	2.21	16
2.11	16	2.18	10.5	2.48	14	2.67	10
3.22	7.5	3.02	3	2.23	24.5	2.12	4
2.39	23	2.35	28	2.16	21	2.49	22
3.29	3	2.97	6	2.15	20	2.2	5
				3.22	7.5	2.94	7
				2.29	30.5	2.41	31
				2.25	28	2.31	21
				2.33	27	2.58	14.5
				2.65	11	2.59	11
				2.36	26	2.29	18.5
				2.27	32	2.49	23
				2.44	18.5	2.50	19
				2.00	4.5	2.15	8
				2.10	13	2.20	13
				2.29	30.5	2.39	*
				2.26	29	2.45	27
				2.27	*	2.36	29
				2.00	4.5	2.09	1
				2.06	9	2.38	32
Rank sum	114.5		142.5		413.5		385.5

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.19	3	2.84	6	2.52	19	2.51	15
2.23	13	2.27	16	2.17	9	2.03	1
2.41	21	2.34	22	2.18	12	2.31	20.5
2.07	1	2.10	5	2.11	4	2.04	4
2.95	7	3.00	3	2.57	18	2.20	9
2.74	15	2.48	18	2.30	16.5	2.24	12
2.84	11	2.64	10	2.49	22	2.35	19
				2.30	16.5	2.19	8
				2.36	20	2.26	13
				2.13	6.5	2.33	*
				2.77	14	2.53	14
				3.08	6	2.63	11
				2.43	*	2.31	20.5
				2.13	6.5	2.29	17
				2.91	10	2.71	7
				3.67	2	3.20	2
Rank sum	71		80		182		173

1996 Graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (X)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.65	2	3.40	2	2.87	11	2.78	14
2.56	8	2.33	4	2.96	10	2.81	11
3.33	3	3.01	6	2.76	*	2.77	*
3.27	6	2.98	7	2.70	12	2.76	13
2.70	13	2.53	9	2.78	14	2.82	10
				2.61	9	2.73	12
				3.17	7	3.28	3
				2.37	4	2.44	5
				2.52	5	2.51	8
				2.17	1	2.15	1
Rank sum	32		28		73		77

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.16	6	2.81	10	2.69	14.5	2.82	7
2.46	12	2.32	12	2.69	14.5	2.39	17
2.02	1	2.06	1	2.53	*	2.46	18
2.06	5	2.08	4	2.56	18	2.51	15
3.57	2	3.06	3	2.94	10	2.93	6
2.52	17	2.44	*	2.49	14.5	2.28	8.5
2.49	14.5	2.36	16	2.84	11	2.64	11
				3.50	3	3.14	9
				2.04	4	2.10	5
				2.08	8	2.28	8.5
				3.08	7	2.58	14
				2.29	9	2.35	13
Rank sum	57.5		46		113.5		125

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.12	9	2.13	1	3.11	2	2.57	7
2.25	15	2.18	9	2.42	14	2.45	15
2.57	10	2.30	16	3.08	3	2.89	2
				2.04	2.5	2.34	*
				2.22	16	2.17	6.5
				2.21	13	2.20	12
				2.25	*	2.56	10
				2.81	6	2.56	11
				2.15	12	2.45	14
				2.79	7	2.58	6
				2.06	5	2.26	13
				2.09	8	2.17	6.5
				2.43	11	2.63	3
				2.04	2.5	2.14	4
Rank sum	34		26		102		110

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.82	6	2.43	11	2.17	8	2.10	4
3.11	3	3.12	2	2.74	7	2.62	7
3.45	2	3.09	3	2.46	12	2.53	10
2.39	9	2.26	9	2.48	11	2.67	6
				2.64	10	2.32	12
				2.02	4	2.11	5
				2.13	5	2.12	8
				2.00	1	2.05	1
Rank sum	20		25		58		53

1997 Graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (X)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.89	15	2.70	23.66	2.83	20.5	2.73	15
2.25	20	2.28	15.33	2.69	35.66	2.66	31
2.92	14	2.78	12.5	2.80	24.5	2.68	23.5
2.71	30.5	2.71	18.5	2.38	33	2.15	5
2.37	32	2.32	27.33	3.49	2	3.35	32
2.50	41	2.32	27.33	2.07	6.5	2.28	15.33
3.10	7	2.78	12.5	2.64	39	2.31	22.5
2.83	20.5	2.70	23.66	3.24	6	2.82	7
2.71	30.5	2.70	23.66	3.02	10	2.87	6
				2.31	25.66	2.49	*
				2.04	2.5	2.31	22.5
				2.44	37	2.30	20
				3.40	3	3.22	2
				2.31	25.66	2.32	27.33
				2.80	24.5	2.68	23.5
				2.60	42	2.55	35
				2.33	29	2.40	38.5
				2.04	2.5	2.25	9
				2.73	27	2.97	3
				2.69	35.66	2.80	10
				2.11	10.5	2.13	4
				2.11	10.5	2.40	38.5
				2.54	*	2.54	38.5
				2.22	9.5	2.37	33
				2.69	35.66	2.42	41
				2.42	36	2.56	34
				2.98	11	2.71	18.5
				2.31	25.66	2.27	12
				2.47	40	2.54	38.5
				2.24	17	2.39	36
				2.20	9.5	2.28	15.33
				2.85	18	2.53	42
				2.07	6.5	2.03	1
				2.28	21	2.24	8
Rank sum	210.5		184.5		692.5		718.5

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.49	*	2.29	20	3.12	3	2.80	7
3.81	2	3.53	2	2.43	20	2.37	17
3.07	6	2.55	14	2.57	18	2.51	18
2.77	15	2.52	15	2.27	13	2.25	9
2.51	19	2.30	16	3.06	7	2.85	6
2.92	14	2.60	11	2.33	16	2.43	19
2.38	17	2.40	*	2.14	9	2.26	12.5
				2.98	11	2.98	3
				2.24	12	2.26	12.5
				3.00	10	2.70	10
				2.04	6.5	2.20	5
				2.04	6.5	2.23	8
				2.00	1	2.15	4
				2.03	4	2.09	1
Rank sum	73		78		137		153

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.09	20	2.10	6.5	2.60	14	2.55	11
2.19	44	2.21	24.5	3.30	3	3.15	2
2.41	23	2.28	44	2.23	42	2.30	43
2.37	27	2.29	45	2.21	43	2.25	33
2.35	32.5	2.27	40	2.06	14.5	2.19	20
2.51	15	2.36	28.5	2.13	28	2.11	9
2.34	34.5	2.27	40	2.15	32	2.10	6.5
2.90	7	2.58	10	2.19	44	2.06	4
				2.04	9	2.12	12.5
				2.12	24.5	2.25	33
				2.15	32	2.44	20.5
				2.15	32	2.44	20.5
				2.06	14.5	2.41	26
				2.85	10	2.85	7
				2.29	38	2.32	34
				2.00	4	2.17	16
				2.19	44	2.46	18
				2.50	18	2.42	23
				2.25	39	2.23	29
				2.17	36.5	2.22	28
				2.19	44	2.18	17
				2.35	32.5	2.30	43
				3.45	2	3.09	3
				2.10	21	2.36	28.5
				2.19	44	2.31	38
				2.17	36.5	2.51	15
				2.02	8	2.04	1
				3.06	6	2.95	6
				2.12	24.5	2.21	24.5
				2.62	11	2.31	38
				2.42	22	2.34	31
				2.08	17	2.27	40
				2.05	12	2.25	33
				2.38	26	2.30	43
				2.46	19	2.54	14
				2.00	4	2.12	12.5
				2.00	4	2.20	21
				2.34	34.5	2.31	38
Rank sum	203		238.5		878		842.5

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.48	13.5	2.51	11	2.46	12	2.52	10
3.37	3	3.21	2	2.13	5	2.35	10.5
2.72	7	2.63	6.5	2.06	4	2.38	13
2.48	13.5	2.35	8.5	2.53	10	2.22	5
3.43	2	3.12	3	2.19	8	2.15	2.5
				2.50	11	2.63	6.5
				2.45	9	2.41	14
				2.73	6	2.31	8
				2.02	1	2.15	2.5
Rank sum	39		31		66		74

1998 graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.42	21	2.21	8.5	2.21	8	2.32	18.5
3.17	10	2.87	12.5	2.77	30	2.58	34.5
3.11	14	2.92	10	3.33	6	2.80	19
2.79	26	2.58	34.5	2.77	30	2.67	27
3.14	11	2.76	22	2.24	12.5	2.32	18.5
2.22	9	2.25	12	2.96	19	3.00	6
2.56	32	2.38	28.5	2.45	25	2.34	21
2.59	33	2.45	32	2.31	16.5	2.38	28.5
3.32	7	2.93	7	3.10	15	2.86	15
2.68	*	2.47	36	2.73	34	2.87	12.5
2.43	24	2.37	25	3.58	3	3.31	3
2.70	35	2.53	*	3.56	2	3.22	2
2.24	12.5	2.31	16	2.77	30	2.81	18
				2.09	4.5	2.21	8.5
				2.54	29	2.46	33
				2.09	4.5	2.16	1
				2.46	28	2.20	5
				3.05	18	2.73	26
				2.63	36	2.63	30.5
				2.40	20	2.35	24
				2.81	23	2.75	23
				2.31	16.5	2.27	13
				2.87	22	2.63	30.5
				2.00	1	2.17	4
Rank sum	234.5		244		846.5		837

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.83	11	2.57	14	2.25	12	2.12	1
3.94	2	3.66	2	2.20	9	2.24	12
2.11	4	2.14	4	2.49	17	2.38	17
2.66	15	2.60	11	2.49	*	2.46	*
2.96	6.5	2.71	6	2.53	18	2.25	13
2.69	14	2.34	16	2.27	14.5	2.48	18
2.98	3	2.66	10	2.27	14.5	2.22	8
				2.84	10	2.83	3
				2.96	6.5	2.68	7
				2.12	5	2.20	5
				2.02	1	2.23	9
				2.17	8	2.56	15
Rank sum	55.5		63		115.5		108

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.08	8.5	2.09	1	3.67	2	3.45	3
3.54	3	3.52	2	3.00	10	2.72	15
2.87	14	2.75	14	3.18	6	2.78	10
2.91	11	2.81	7	2.42	23	2.43	22
2.47	22	2.17	12	2.04	4	2.31	21
2.56	18	2.67	18	2.26	20	2.29	20
2.40	24	2.28	17	2.27	21	2.26	16
2.08	8.5	2.10	4	3.05	7	3.09	6
2.50	19	2.39	23.5	2.24	17	2.16	9
				2.07	5	2.12	5
				2.18	16	2.51	19
				2.11	12	2.18	13
				2.16	13	2.39	23.5
				2.71	15	2.76	11
				2.03	1	2.14	8
Rank sum	128		98.5		172		201.5

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.94	15	2.74	14	2.22	37	2.13	8.5
2.78	19	2.53	26.5	2.22	37	2.15	16.5
2.35	39	2.20	28	3.00	11	2.95	10
2.28	50.5	2.32	52	2.26	48.5	2.31	49
2.31	47	2.22	32.5	2.12	12	2.40	39
2.18	24.5	2.13	10.5	2.32	43	2.25	44.5
2.45	31	2.50	31	2.21	32	2.24	40.5
2.26	48.5	2.10	8	2.18	24.5	2.14	13
2.03	5	2.23	36.5	2.80	18	2.73	15
2.19	29	2.21	29	2.13	13	2.23	36.5
				2.14	16.5	2.35	50.5
				2.14	16.5	2.17	24
				2.28	50.5	2.50	31
				2.02	2.5	2.30	48
				2.26	48.5	2.16	20.5
				2.73	22	2.38	42.5
				3.40	7	2.99	7
				2.27	*	2.18	25
				2.36	38	2.41	38
				2.52	30	2.42	35
				3.18	10	2.69	18
				3.42	4.5	3.06	6
				2.18	24.5	2.59	19
				2.62	26	2.55	22
				2.44	34	2.22	32.5
				3.42	4.5	3.11	3
				2.32	43	2.53	26.5
				2.04	8.5	2.01	1
				2.22	37	2.24	40.5
				2.22	37	2.16	20.5
				2.64	23	2.54	23
				2.24	44	2.37	46
				2.22	37	2.05	4
				2.40	35	2.25	44.5
				2.96	14	2.87	11
				2.26	48.5	2.15	16.5
				2.58	27	2.36	47
				3.90	2	3.65	2
				2.16	20	2.50	31
				2.04	8.5	2.08	5
				2.32	43	2.38	42.5
				2.02	2.5	2.32	*
				2.18	24.5	2.35	50.5
Rank sum	308.5		268		1069.5		1110