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

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Abstract: *Empirical results of the academic performance of four batches of graduates from the natural science streams of the Faculty of Science, Addis Ababa University are provided. A non-parametric statistical analysis based on the ranks of achievement of graduates in the major subject areas as well as in overall performance was conducted. The purpose of the undertaking was to see if students from the teacher and non-teacher streams performed differently. The results revealed against the commonly held bias, that there is no significant difference in the performance of the two categories of students in spite of the fact that those who were streamlined into the non-teacher programmes performed better than the other group at the end of their freshman year. This was true for all batches who graduated in July 1995, 1996, 1997 and 1998.*

Introduction

Since a couple of years now, Addis Ababa University has been running undergraduate non-teacher and teacher programmes at the Faculty of Science. The latter aims at training science teachers for high schools in the country in four subject areas--Biology, Chemistry, Mathematics and Physics. The former trains personnel who could engage themselves in other relevant sectors of the economy. The induction mechanism of students into these two streams is based on academic achievement at the end of the freshman year. It has been noted that those who join the teacher stream are, in relative terms, low achievers as far as their first year grades are concerned when compared with those who join the pure science streams. As a result, there prevails some kind of bias against would-be teachers in the sense that these would continue to perform the same way in the remaining six semesters. A direct consequence of such thinking may lead to the conclusion that the graduates from the teacher stream may not perform as good as their counterparts in the pure science areas. The purpose of this study is to conduct an empirical

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investigation which will show if the presumed belief is well founded or not.

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 uses ranks, namely the *Two-sample Wilcoxon Rank-sum Test* (Gibbons and Chakraborti, 1992; Hollander and Wolfe, 1973). This test is used to find out if there is a difference in location parameters of the distribution of two populations. As a non-parametric test, the Wilcoxon test is used to check for the existence of a difference in the empirical medians of the two samples. Answers related to such a difference in performance (attributable to a shift in location) can be obtained by considering the final grades of the graduates.

One objective of this work is to create awareness among researchers in the education sector about the significance of non-parametric statistical methods. These methods do not involve the kind of rigour and theoretical sophistication as the parametric statistical methods. A very important point that the reader should pay attention to is the fact that *only* the non-parametric theory provides the opportunity to test differences in location and variation of distributions. Here, one need not bother to know the exact form of the distribution from which the sample for the study comes. The assumption of continuity, and sometimes symmetry of the unknown distribution is enough to perform a test discussed in the paper. Another paper by the author will demonstrate how a non-parametric test will be applied to show if there is a difference in the dispersion of two populations. A counterpart test of the like is not provided by the parametric theory. Researchers in education are well advised to ponder long enough before they decide for a parametric technique. In many instances there are friendly non-parametric options that could be applied with great ease.

As far as the author knows, there are no similar comparative studies like the one presented in this paper.

The Statistical Problem and its Solution

Assumptions: We use the variables X and Y to stand for the overall Cumulative Grade-point Average (CGPA) and the major CGPA (MGPA) of non-teacher and teacher stream graduates, respectively. Furthermore, we assume that X and Y have unknown continuous distributions F and G which may differ in their medians. Since non-parametric statistical methods do not impose restrictions more than continuity (and sometimes symmetry) of the unknown distributions we use them with great ease in research related to education, psychology, medicine, etc. An additional assumption is that the samples we obtain from X and Y are independent.

Study Variables: For the purpose of the empirical investigation the CGPA and MGPA of four batches of graduates who completed their studies in July of 1995, 1996, 1997 and 1998 were considered. These data were obtained from the Registrar Office of Addis Ababa University. The number of graduates of both programmes and their grades are given in the Appendix.

Pooling the data: Suppose there are *m* observations from **X** and *n* observations from **Y**. This could be denoted 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 two or more observations of equal size, then assign the average rank in the tied group.

The statistical problem: In the formulation of the statistical hypothesis that follows **z** is any possible value for CGPA or MGPA. Hence, the statistical hypothesis is given as

H_0: $G(z) = F(z)$ versus H_1: $G(z) = F(z - \theta)$ for all $z \in R$, and for some $\theta \neq 0$.

The above formulation will be understood as follows: We contend that the distributions F and G of grades of the non-teacher stream graduates and that of the teacher stream graduates do not differ. This stipulation about the equality of the two distributions F and G is referred to as the null-hypothesis. On the other hand, the contest that underscores the existence of a difference in distributions is called the alternative hypothesis. It is worth mentioning that this is not the only alternative; there are other alternatives. But as far as the problem we posed is concerned the alternative hypothesis given above suffices to give reliable answers.

Construction of the test statistic: Take the sum of the ranks of the **X** variable in the newly formed sample of size $n+m$. This sum could take any possible value, and, therefore, unpredictable. As a result it is *random variable*. A random variable, which is used to test a hypothesis, 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%.

In our case the sum of the ranks of the x-observations will be compared with tabulated values in standard non-parametric books/works to reach a decision about rejection or not rejection of the null-hypothesis. Tabulated values, of course, 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 (of not falsely rejecting a null-hypothesis) are sought, then the corresponding levels of significance are α = 10%, 5 % or 1%, respectively. Usually α is given in decimals as 0.1, 0.05 or 0.01.

The decision rules: Suppose we agree to regard the sum $m + n$ as N, which is now the size of the pooled sample. Let W_N stand for the test statistic that represents the sum of the ranks of the x-values in the bigger sample of size N. Further, assume m is at most equal to n.

At this stage we distinguish between what are called small-sample and large-sample properties. What we refer to as a small sample, here, is a situation where each of *m* and *n* is not larger than 25. In such a case, for the problem at hand, we can use the Table for the Wilcoxon rank sum test; when *m* and/or *n* is greater than 25 the sample is considered large. Since we are now clear about the steps involved in obtaining values of W_N for a given configuration of *m*, *n* as well as the a priori fixed level of significance α it would be time to introduce the decision rules.

Test Rule 1 (small-sample case):

Reject H_0 if $w_N(m, n) \geq w(m, n; 1-\alpha/2)$ or $w_N(m, n) \leq w(m, n; \alpha/2)$; otherwise do not reject H_0.

Test Rule 2 (large-sample case):

Reject H_0 if $|z_N| \geq z(1-\alpha/2)$; otherwise do not reject H_0.

In the above two decision rules: $w_N(m, n)$ represents the computed value of W_N for given m and n, while $w(m,n; \alpha/2)$ is a value that is available in Tables. The other quantity $w(m, n; 1-\alpha/2) = m(N+1) - w(m, n; \alpha/2)$.

On the other hand, z_N stands for the computed value of the standardised W_N given by

$$Z_N = [W_N - E(W_N)]/\text{s.d.}(W_N).$$

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

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

The term s.d.(W_N) in the expression for W_N is the square root of the variance, which is the standard deviation of W_N.

We would like to remark that the value of $E(W_N)$ 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 W_N, which are given as w_N (m,n) and values of w (m, n; $\alpha/2$) and w (m, n; 1- $\alpha/2$) at α = 0.05. The z_N-values are compared with z(0.975) .

A. For the graduates of **July 1995**:

Overall CGPA

Biology w_{20} = 113; w(10, 10; 0.025) = 78 <113 ; w(10, 10; 0.975) = 132 > 113
Chemistry w_{30} = 218; w(12, 18; 0.025) = 138 <218 ;w(12, 18; 0.975) = 234 > 218
Mathematics w_{33} =187.5; w(9, 24; 0.025) =104 <187.5 ; w(9, 24; 0.975)=212 > 187.5
Physics w_{23} = 101; w(7, 16; 0.025) = 54 <101 ; w(7, 16; 0.975) = 114 > 101

Major CGPA

Biology w_{20} =112; w(10, 10; 0.025) = 78 <112 ; w(10, 10; 0.975) = 132 > 112
Chemistry w_{30} = 263; w(12, 18; 0.025) = 138 <263 ; w(12, 18; 0.975) = 234 < 263*
Mathematics w_{33}=212.5;w(9, 24; 0.025)=104<212.5; w(9, 24;0.975)=212< 212.5*
Physics w_{23} = 94; w(7, 16; 0.025) = 54 <94 ;.w(7, 16; 0.975) = 114 > 94

B. For the graduates of **July 1996**:

Overall CGPA

Biology w_{15} = 47; w(5, 10; 0.025) = 23 < 47; w(5, 10; 0.975) = 57 > 47
Chemistry w_{19} = 60; w(7, 12; 0.025) = 46 < 60; w(7, 12; 0.975) = 94 > 60
Mathematics w_{17} = 14; w(3, 14; 0.025) = 11 < 14; w(3, 4; 0.975) = 43 > 14
Physics w_{12} = 35; w(4, 8; 0.025) = 14 < 35; w(4, 8; 0.975) = 38 > 35

Major CGPA

Biology w_{15} = 52.5; w(5, 10; 0.025) = 23 < 52.5; w(5, 10; 0.975) = 57 > 52.5
Chemistry w_{19} = 62.5; w(7, 12; 0.025) = 46 < 62.5; w(7, 12; 0.975) = 94 > 62.5
Mathematics w_{17} = 27.5; w(3, 14; 0.025) = 11 < 27.5; w(3, 4; 0.975) = 43 > 27.5
Physics w_{12} = 38; w(4, 8; 0.025) = 14 < 38; w(4, 8; 0.975) = 38 = w_{12}*

C. For the graduates of **July 1997**:

Overall CGPA

Biology	$w_{43} = 241.5$; $z_{43} = 1.30 < 1.96 = z(0.975)^{**}$
Chemistry	$w_{21} = 95$; $w(7, 14; 0.025) = 50 < 95$; $w(7, 14; 0.975) = 104 > 95$
Mathematics	$w_{46} = 175.5$; $z_{46} = -0.36 \Rightarrow \lvert z_{46} \rvert = 0.36 < 1.96 = z(0.975)^{**}$
Physics	$w_{14} = 53$; $w(5, 9; 0.025) = 22 < 53$; $w(5, 9; 0.975) = 53 = w_{14}$

Major CGPA

Biology	$w_{43} = 250.5$; $z_{43} = 1.57 < 1.96 = z(0.975)^{**}$
Chemistry	$w_{21} = 101$; $w(7, 14; 0.025) = 50 < 101$; $w(7, 14; 0.975) = 104 > 101$
Mathematics	$w_{46} = 243$; $z_{46} = 1.59 < 1.96 = z(0.975)^{**}$
Physics	$w_{14} = 53$; $w(9, 15; 0.025) = 53 = 53$; $w(9, 15; 0.975) = 146 > 53$

D. For the graduates of **July 1998**:

Overall CGPA

Biology	$w_{37} = 249.5$; $w(13, 24; 0.025) = 185 < 249.5$; $w(13, 24; 0.975) = 309 > 249.5$
Chemistry	$w_{19} = 88$; $w(7, 12; 0.025) = 46 < 88$; $w(7, 12; 0.975) = 94 > 88$
Mathematics	$w_{53} = 225.5$; $z_{53} = -1.01 \Rightarrow \lvert z_{53} \rvert = 1.01 < 1.96 = z(0.975)^{**}$
Physics	$w_{24} = 109.5$; $w(9, 15, 0.025) = 79 < 109.5$; $w(9, 15; 0.975) = 146 > 109.5$

Major CGPA

Biology	$w_{37} = 261.5$; $w(13, 24; 0.025) = 185 < 265.5$; $w(13, 24; 0.975) = 309 > 265.5$
Chemistry	$w_{19} = 94.5$; $w(7, 12; 0.025) = 46 \leq 94.5$; $w(7, 12; 0.975) = 94 < 94.5^{*}$
Mathematics	$w_{53} = 275.5$; $z_{53} = 0.13 < 1.96 = z(0.975)^{**}$
Physics	$w_{24} = 126$; $w(9, 15; 0.025) = 79 < 126$; $w(9, 15; 0.975) = 146 > 126$

The numerical results without asterisk and with a single asterisk, according Test Rule **1**, indicate that the hypothesis that there is no difference in overall performance as well as in performance in the major subject area cannot be rejected with 95% confidence. Those results with double asterisk refer to those samples where the y-observations are more than 25, and as a consequence a standardisation was necessary. These also indicate that the hypothesis cannot be rejected (Test Rule **2**).

Conclusion

The statistical analysis indicated that all four batches of graduates from the teacher and non-teacher streams in the four subject areas - Biology, Chemistry, Mathematics and Physics in the Faculty of Science, Addis Ababa University performed equally well. The apparent disparity at the stage of induction where those who joined the non-teacher stream had relatively higher grades at the end of the freshman year did not make any difference in the achievement in the successive three years of their stay in the Faculty. This empirical study, of course, cannot provide concrete reasons and arguments why the observed results led to the conclusion pointed out earlier. What could be said is simply that the apparent differences in first year results were not that significant or serious enough to gauge performance in the semesters to come as far as the two groups of entrants are concerned.

One last aspect that is worth pointing out is related to differences in credit hours in the major subject areas as well as in pedagogical courses. The author is fully aware of this situation, but still feels that such marginal differences would not influence the outcome of the research undertaking to a significant degree.

References

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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) including ranking

1995 graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.13	16	2.64	11	2.36	5	2.28	2.5
2.89	10	2.49	9	2.22	2	2.32	5.5
2.34	4	2.33	7	2.63	9	2.28	2.5
3.03	13	2.77	15.5	2.15	1	2.32	5.5
2.46	6	2.29	4	3.08	15	2.75	14
3.92	20	3.65	20	3.33	18	3.08	18
3.22	17	2.86	17	3.54	19	3.26	19
2.91	11	2.71	13	2.56	7	2.68	12
2.29	3	2.21	1	2.57	8	2.47	8
2.97	12	2.77	15.5	3.04	14	2.59	10
Rank sum	112		113		98		97

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.69	24	2.46	19	2.33	15	2.28	12
2.30	14	2.19	7.5	2.89	26.5	2.82	28
2.43	17	2.35	16	2.00	2.5	2.12	2.5
2.12	11	2.21	9	2.00	2.5	2.16	5.5
3.00	28	2.66	25	2.10	9.5	2.12	2.5
2.68	23	2.49	20	2.41	16	2.79	27
2.71	25	2.56	22	2.23	13	2.26	11
2.52	21	2.34	14.5	2.89	26.5	2.94	29
3.27	30	3.09	30	2.14	12	2.19	7.5
2.64	22	2.45	18	2.09	8	2.16	5.5
3.03	29	2.63	24	2.00	2.5	2.00	1
2.48	19	2.31	13	2.44	18	2.75	26
				2.49	20	2.56	22
				2.00	2.5	2.56	22
				2.04	6	2.34	14.5
				2.02	5	2.14	4
				2.10	9.5	2.41	17
				2.08	7	2.24	10
Rank sum	263		218		202		247

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.40	23	2.51	25	2.00	2.5	2.29	9.5
2.13	9	2.35	13	2.00	2.5	2.18	5.5
3.41	33	3.20	33	2.23	12.5	2.42	19
2.47	26	2.35	13	2.44	24.5	2.58	26.5
2.70	29	2.49	22	2.08	6	2.21	8
2.11	8	2.18	5.5	2.48	27	2.67	29
3.22	30.5	3.02	32	2.23	12.5	2.12	2.5
2.39	22	2.35	13	2.16	11	2.49	22
3.29	32	2.97	31	2.15	10	2.2	2.5
				3.22	30.5	2.94	30
				2.29	18.5	2.41	18
				2.25	14	2.31	11
				2.33	20	2.58	26.5
				2.65	28	2.59	28
				2.36	21	2.29	9.5
				2.27	16.5	2.49	22
				2.44	24.5	2.50	24
				2.00	2.5	2.15	4
				2.10	7	2.20	7
				2.29	18.5	2.39	17
				2.26	15	2.45	20
				2.27	16.5	2.36	15
				2.00	2.5	2.09	1
				2.06	5	2.38	16
Rank sum	212.5		187.5		348.5		373.5

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.19	22	2.84	21	2.52	14	2.51	16
2.23	7	2.27	8	2.17	5	2.03	1
2.41	11	2.34	13	2.18	6	2.31	10.5
2.07	1	2.10	3	2.11	2	2.04	2
2.95	20	3.00	22	2.57	15	2.20	5
2.74	16	2.48	15	2.30	8.5	2.24	6
2.84	18	2.64	19	2.49	13	2.35	14
				2.30	8.5	2.19	4
				2.36	10	2.26	7
				2.13	3.5	2.33	12
				2.77	17	2.53	17
				3.08	21	2.63	18
				2.43	12	2.31	10.5
				2.13	3.5	2.29	9
				2.91	19	2.71	20
				3.67	23	3.20	23
Rank sum	94		101		182		175

1996 graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (X)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.65	15	3.40	15	2.87	10	2.78	9
2.56	4	2.33	2	2.96	11	2.81	10
3.33	14	3.01	13	2.76	8	2.77	8
3.27	13	2.98	12	2.70	6.5	2.76	7
2.70	6.5	2.53	5	2.78	9	2.82	11
				2.61	5	2.73	6
				3.17	12	3.28	14
				2.37	2	2.44	3
				2.52	3	2.51	4
				2.17	1	2.15	1
Rank sum	52.5		47		67.5		73

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
3.16	17	2.81	15	2.69	12.5	2.82	16
2.46	6	2.32	6	2.69	12.5	2.39	9
2.02	1	2.06	1	2.53	10	2.46	11
2.06	3	2.08	2	2.56	11	2.51	12
3.57	19	3.06	18	2.94	15	2.93	17
2.52	9	2.44	10	2.49	7.5	2.28	4.5
2.49	7.5	2.36	8	2.84	14	2.64	14
				3.50	18	3.14	19
				2.04	2	2.10	3
				2.08	4	2.28	4.5
				3.08	16	2.58	13
				2.29	5	2.35	7
Rank sum	62.5		60		127.5		130

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.12	5	2.13	1	3.11	17	2.57	14
2.25	9.5	2.18	5	2.42	11	2.45	10.5
2.57	13	2.30	8	3.08	16	2.89	17
				2.04	1.5	2.34	9
				2.22	8	2.17	3.5
				2.21	7	2.20	6
				2.25	9.5	2.56	12.5
				2.81	15	2.56	12.5
				2.15	6	2.45	10.5
				2.79	14	2.58	15
				2.06	3	2.26	7
				2.09	4	2.17	3.5
				2.43	12	2.63	16
				2.04	1.5	2.14	2
Rank sum	27.5		14		125.5		139

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.82	10	2.43	7	2.17	4	2.10	2
3.11	11	3.12	12	2.74	9	2.62	9
3.45	12	3.09	11	2.46	6	2.53	8
2.39	5	2.26	5	2.48	7	2.67	10
				2.64	8	2.32	6
				2.02	2	2.11	3
				2.13	3	2.12	4
				2.00	1	2.05	1
Rank sum	38		35		40		43

1997 graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (X)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.89	36	2.70	32	2.83	33.5	2.73	36
2.25	10	2.28	8	2.69	26	2.66	28
2.92	37	2.78	37.5	2.80	31.5	2.68	29.5
2.71	28.5	2.71	34.5	2.38	17	2.15	3
2.37	16	2.32	14	3.49	43	3.35	16
2.50	21	2.32	14	2.07	3.5	2.28	8
3.10	40	2.78	37.5	2.64	24	2.31	11.5
2.83	33.5	2.70	32	3.24	41	2.82	40
2.71	28.5	2.70	32	3.02	39	2.87	41
				2.31	13	2.49	22
				2.04	1.5	2.31	11.5
				2.44	19	2.30	10
				3.40	42	3.22	43
				2.31	13	2.32	14
				2.80	31.5	2.68	29.5
				2.60	23	2.55	26
				2.33	15	2.40	19.5
				2.04	1.5	2.25	5
				2.73	30	2.97	42
				2.69	26	2.80	39
				2.11	5.5	2.13	2
				2.11	5.5	2.40	19.5
				2.54	22	2.54	24.5
				2.22	7.5	2.37	17
				2.69	26	2.42	21
				2.42	18	2.56	27
				2.98	38	2.71	34.5
				2.31	13	2.27	6
				2.47	20	2.54	24.5
				2.24	9	2.39	18
				2.20	7.5	2.28	8
				2.85	35	2.53	23
				2.07	3.5	2.03	1
				2.28	11	2.24	4
Rank sum	250.5		241.5		310.5		319.5

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.49	11	2.29	10	3.12	20	2.80	18
3.81	21	3.53	21	2.43	10	2.37	9
3.07	19	2.55	15	2.57	13	2.51	13
2.77	14	2.52	14	2.27	7	2.25	5
2.51	12	2.30	8	3.06	18	2.85	19
2.92	15	2.60	16	2.33	8	2.43	12
2.38	9	2.40	11	2.14	5	2.26	6.5
				2.98	16	2.98	20
				2.24	6	2.26	6.5
				3.00	17	2.70	17
				2.04	3.5	2.20	3
				2.04	3.5	2.23	4
				2.00	1	2.15	2
				2.03	2	2.09	1
Rank sum	101		95		130		136

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.09	10	2.10	3.5	2.60	40	2.55	41
2.19	22	2.21	12.5	3.30	45	3.15	46
2.41	35	2.28	22	2.23	26	2.30	25
2.37	33	2.29	23	2.21	25	2.25	17
2.35	31.5	2.27	20	2.06	7.5	2.19	10
2.51	39	2.36	32.5	2.13	14	2.11	5
2.34	29.5	2.27	20	2.15	16	2.10	3.5
2.90	43	2.58	42	2.19	22	2.06	2
				2.04	5	2.12	6.5
				2.12	12.5	2.25	17
				2.15	16	2.44	36.5
				2.15	16	2.44	36.5
				2.06	7.5	2.41	34
				2.85	42	2.85	43
				2.29	28	2.32	30
				2.00	2	2.17	8
				2.19	22	2.46	38
				2.50	38	2.42	35
				2.25	27	2.23	15
				2.17	18.5	2.22	14
				2.19	22	2.18	9
				2.35	31.5	2.30	25
				3.45	46	3.09	45
				2.10	11	2.36	32.5
				2.19	22	2.31	28
				2.17	18.5	2.51	39
				2.02	4	2.04	1
				3.06	44	2.95	44
				2.12	12.5	2.21	12.5
				2.62	41	2.31	28
				2.42	36	2.34	31
				2.08	9	2.27	20
				2.05	6	2.25	17
				2.38	34	2.30	25
				2.46	37	2.54	40
				2.00	2	2.12	6.5
				2.00	2	2.20	11
				2.34	29.5	2.31	28
Rank sum	243		175.5		838		905.5

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.48	7.5	2.51	9	2.46	6	2.52	10
3.37	13	3.21	14	2.13	3	2.35	5.5
2.72	11	2.63	11.5	2.06	2	2.38	7
2.48	7.5	2.35	5.5	2.53	10	2.22	3
3.43	14	3.12	13	2.19	4	2.15	1.5
				2.50	9	2.63	11.5
				2.45	5	2.41	8
				2.73	12	2.31	4
				2.02	1	2.15	1.5
Rank sum	53		53		52		52

1998 graduates

Biology

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.42	11	2.21	4.5	2.21	4	2.32	9.5
3.17	33	2.87	31.5	2.77	23	2.58	20.5
3.11	31	2.92	33	3.33	35	2.80	28
2.79	25	2.58	20.5	2.77	23	2.67	24
3.14	32	2.76	27	2.24	6.5	2.32	9.5
2.22	5	2.25	6	2.96	28	3.00	35
2.56	16	2.38	14.5	2.45	13	2.34	11
2.59	17	2.45	16	2.31	8.5	2.38	14.5
3.32	34	2.93	34	3.10	30	2.86	30
2.68	19	2.47	18	2.73	21	2.87	31.5
2.43	12	2.37	13	3.58	36	3.31	36
2.70	20	2.53	19	3.56	37	3.22	37
2.24	6.5	2.31	8	2.77	23	2.81	29
				2.09	2.5	2.21	4.5
				2.54	15	2.46	17
				2.09	2.5	2.16	1
				2.46	14	2.20	3
				3.05	29	2.73	25
				2.63	18	2.63	22.5
				2.40	10	2.35	12
				2.81	26	2.75	26
				2.31	8.5	2.27	7
				2.87	27	2.63	22.5
				2.00	1	2.17	2
Rank sum	261.5		249.5		441.5		453.5

Chemistry

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.83	14	2.57	13	2.25	6	2.12	1
3.94	19	3.66	19	2.20	5	2.24	6
2.11	2	2.14	2	2.49	9.5	2.38	9
2.66	12	2.60	14	2.49	9.5	2.46	10
2.96	16.5	2.71	17	2.53	11	2.25	7
2.69	13	2.34	8	2.27	7.5	2.48	11
2.98	18	2.66	15	2.27	7.5	2.22	4
				2.84	15	2.83	18
				2.96	16.5	2.68	16
				2.12	3	2.20	3
				2.02	1	2.23	5
				2.17	4	2.56	12
Rank sum	94.5		88		95.5		102

Mathematics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.94	46	2.74	47	2.22	19	2.13	5.5
2.78	44	2.53	40.5	2.22	19	2.15	8.5
2.35	34	2.20	14	3.00	48	2.95	49
2.28	28.5	2.32	26.5	2.26	24.5	2.31	25
2.31	30	2.22	16.5	2.12	6	2.40	34
2.18	12.5	2.13	5.5	2.32	32	2.25	22.5
2.45	38	2.50	38	2.21	16	2.24	20.5
2.26	24.5	2.10	4	2.18	12.5	2.14	7
2.03	3	2.23	18.5	2.80	45	2.73	46
2.19	15	2.21	15	2.13	7	2.23	18.5
				2.14	8.5	2.35	28.5
				2.14	8.5	2.17	12
				2.28	28.5	2.50	38
				2.02	1.5	2.30	24
				2.26	24.5	2.16	10.5
				2.73	43	2.38	32.5
				3.40	50	2.99	50
				2.27	27	2.18	13
				2.36	35	2.41	35
				2.52	39	2.42	36
				3.18	49	2.69	45
				3.42	51.5	3.06	51
				2.18	12.5	2.59	44
				2.62	41	2.55	43
				2.44	37	2.22	16.5
				3.42	51.5	3.11	52
				2.32	32	2.53	40.5
				2.04	4.5	2.01	1
				2.22	19	2.24	20.5
				2.22	19	2.16	10.5
				2.64	42	2.54	42
				2.24	22	2.37	31
				2.22	19	2.05	2
				2.40	36	2.25	22.5
				2.96	47	2.87	48
				2.26	24.5	2.15	8.5
				2.58	40	2.36	30
				3.90	53	3.65	53
				2.16	10	2.50	38
				2.04	4.5	2.08	3
				2.32	32	2.38	32.5
				2.02	1.5	2.32	26.5
				2.18	12.5	2.35	28.5
Rank sum	275.5		225.5		1155.5		1205.5

Physics

Non-teacher stream graduates (X)				Teacher stream graduates (Y)			
MGPA	Rank	CGPA	Rank	MGPA	Rank	CGPA	Rank
2.08	4.5	2.09	1	3.67	24	3.45	23
3.54	23	3.52	24	3.00	20	2.72	17
2.87	18	2.75	18	3.18	22	2.78	20
2.91	19	2.81	21	2.42	13	2.43	14
2.47	14	2.17	6	2.04	2	2.31	11
2.56	16	2.67	16	2.26	10	2.29	10
2.40	12	2.28	9	2.27	11	2.26	8
2.08	4.5	2.10	2	3.05	21	3.09	22
2.50	15	2.39	12.5	2.24	9	2.16	5
				2.07	3	2.12	3
				2.18	8	2.51	15
				2.11	6	2.18	7
				2.16	7	2.39	12.5
				2.71	17	2.76	19
				2.03	1	2.14	4
Rank sum	126		109.5		174		190.5