Instructor Performance Analysis Using Statistical Linear Models

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Course: Linear Statistical Models II

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Question

A University hired 5 instructors (Love, Joy, Peace, Goodness and Kindness) with the intension of retaining the best three among them, but this intention was not made known to the instructors at the point of hire. Five students were randomly allocated to each of these instructors to train and they were examined periodically on the same questions on five different occasions. The performances of the students are provided in the attached data, INSTRUCTOR INVESTIGATION.

NOTE: Pre-test was given to the five students under each instructor before the commencement of the exercise. It was observed that there was no significant difference in their performances.

Use the three approaches below to provide solution to the University intention.

APPROACH 1: SEPARATE INVESTIGATION OF THE INSTRUCTORS, EXAM BY EXAM.

Analysis in line with the University's objective (at a 0.1 significance level):

Test of Normality:

- $\mathbf{H_0}$: The data follows a normal distribution.
- $\mathbf{H_1}$: The data does not follow a normal distribution.

Tests of Normality

	STUDENT	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
examtotal	1	.209	5	.200*	.910	5	.469
	2	.181	5	.200*	.951	5	.744
	3	.243	5	.200*	.952	5	.754
	4	.190	5	.200*	.976	5	.913
	5	.244	5	.200*	.948	5	.725

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

All p-values>0.01, we fail to reject the null hypothesis.

Conclusion: The exam scores for each student are normally distributed

examtotal

Duncan[a]

STUDENT	N	Subset for alpha = 0.05 1	2	3	4
1.00	5	203.2000			
2.00	5		252.2000		
3.00	5			301.6000	
4.00	5			322.2000	
5.00	5				356.8000
Sig.		1.000	1.000	.222	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Ranking of Instructors:

1. Kindness
2. Goodness
3. Peace

4. Joy
5. Love

Therefore, the best three instructors are Kindness, Goodness, and Peace.

APPROACH 2: INVESTIGATION OF THE INSTRUCTORS USING EXAM TOTAL

Test of normality: H0: The data follows a normal distribution
H1: The data does not follow a normal distribution

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	STUDENT	Statistic	df	Sig.	Statistic	df	Sig.
EXAM1	1	.192	5	.200*	.935	5	.631
	2	.295	5	.178	.881	5	.312
	3	.236	5	.200*	.877	5	.298
	4	.314	5	.120	.848	5	.189
	5	.176	5	.200*	.985	5	.959
EXAM2	1	.200	5	.200*	.968	5	.865
	2	.181	5	.200*	.962	5	.824
	3	.185	5	.200*	.952	5	.749
	4	.326	5	.089	.722	5	.016
	5	.246	5	.200*	.943	5	.684
EXAM3	1	.232	5	.200*	.858	5	.220
	2	.219	5	.200*	.874	5	.285
	3	.198	5	.200*	.926	5	.568
	4	.218	5	.200*	.932	5	.608
	5	.302	5	.153	.863	5	.240
EXAM4	1	.260	5	.200*	.949	5	.727
	2	.264	5	.200*	.929	5	.590
	3	.277	5	.200*	.925	5	.562
	4	.241	5	.200*	.948	5	.721
	5	.333	5	.073	.782	5	.058
EXAM4	1	.260	5	.200*	.949	5	.727
	2	.264	5	.200*	.929	5	.590
	3	.277	5	.200*	.925	5	.562
	4	.241	5	.200*	.948	5	.721
	5	.333	5	.073	.782	5	.058
EXAM5	1	.213	5	.200*	.884	5	.327
	2	.343	5	.055	.775	5	.050
	3	.235	5	.200*	.881	5	.316
	4	.395	5	.011	.762	5	.038
	5	.252	5	.200*	.942	5	.680

*. This is a lower bound of the true significance.

Result:
All p-values > 0.01; we fail to reject the null hypothesis.
Conclusion: The data is normally distributed.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ExamTotal	Between Groups	72787.600	4	18196.900	27.191	.000
	Within Groups	13384.400	20	669.220		
	Total	86172.000	24			
EXAM1	Between Groups	2762.000	4	690.500	4.429	.010
	Within Groups	3118.000	20	155.900		
	Total	5880.000	24			
EXAM2	Between Groups	2705.360	4	676.340	5.118	.005
	Within Groups	2643.200	20	132.160		
	Total	5348.560	24			
EXAM3	Between Groups	3718.160	4	929.540	13.714	.000
	Within Groups	1355.600	20	67.780		
	Total	5073.760	24			
EXAM4	Between Groups	2385.040	4	596.260	10.553	.000
	Within Groups	1130.000	20	56.500		
	Total	3515.040	24			
EXAM5	Between Groups	3973.360	4	993.340	7.875	.001
	Within Groups	2522.800	20	126.140		
	Total	6496.160	24			

Post Hoc Tests:

EXAM1

Duncan[a]

STUDENT	N	Subset for alpha = 0.05	
		1	2
1.00	5	51.4000	
2.00	5	55.6000	
4.00	5	67.8000	67.8000
3.00	5	68.0000	68.0000
5.00	5		81.2000
Sig.		.066	.123

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

EXAM2

Duncan[a]

STUDENT	N	Subset for alpha = 0.05		
		1	2	3
1.00	5	39.0000		
2.00	5	51.4000	51.4000	
3.00	5		62.6000	62.6000
4.00	5		62.8000	62.8000
5.00	5			68.0000
Sig.		.104	.153	.491

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

EXAM3

Duncan[a]

STUDENT	N	Subset for alpha = 0.05		
		1	2	3
1.00	5	46.0000		
2.00	5	53.8000	53.8000	
3.00	5		63.8000	
5.00	5			76.4000
4.00	5			76.8000
Sig.		.150	.069	.940

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

EXAM4

Duncan[a]

STUDENT	N	Subset for alpha = 0.05		
		1	2	3
1.00	5	23.8000		
2.00	5		36.0000	
3.00	5		36.8000	
4.00	5		43.4000	
5.00	5			53.6000
Sig.		1.000	.156	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

EXAM5

Duncan[a]

STUDENT	N	Subset for alpha = 0.05	
		1	2
1.00	5	43.0000	
2.00	5	55.4000	
3.00	5		70.4000
4.00	5		71.4000
5.00	5		77.6000
Sig.		.096	.350

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Ranking of Instructors:

1. Kindness
2. Goodness
3. Peace
4. Joy
5. Love

Therefore, the best three instructors are Kindness, Goodness, and Peace.

APPROACH 3: INVESTIGATION OF THE INSTRUCTORS USING MIXED REPEATED MEASURE ANOVA

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.343	19.697	9	.020	.723	1.000	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + STUDENT
Within Subjects Design: factor1

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Sphericity:

A p-value = 0.020, which is greater than the 0.01 significance level.

Conclusion: Therefore, sphericity is not violated, and no correction is needed when interpreting within-subjects effects.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	11939.280	4	2984.820	29.506	.000
	Greenhouse-Geisser	11939.280	2.891	4130.223	29.506	.000
	Huynh-Feldt	11939.280	4.000	2984.820	29.506	.000
	Lower-bound	11939.280	1.000	11939.280	29.506	.000
factor1 * STUDENT	Sphericity Assumed	986.400	16	61.650	.609	.867
	Greenhouse-Geisser	986.400	11.563	85.308	.609	.820
	Huynh-Feldt	986.400	16.000	61.650	.609	.867
	Lower-bound	986.400	4.000	246.600	.609	.661
Error(factor1)	Sphericity Assumed	8092.720	80	101.159		
	Greenhouse-Geisser	8092.720	57.814	139.978		
	Huynh-Feldt	8092.720	80.000	101.159		
	Lower-bound	8092.720	20.000	404.636		

Test of Within-Subjects Effects (Exams):

According to the Tests of Within-Subjects Effects and using a 0.01, there is a significant difference between exam scores overall p = .000, but no significant interaction between exam scores and student groups p = .867.

Conclusion: No significant interaction between exam scores and student groups. This means all student groups performed similarly across the different exams

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	412419.200	1	412419.200	3081.342	.000
STUDENT	14557.520	4	3639.380	27.191	.000
Error	2676.880	20	133.844		

Test of Between-Subjects Effects (Instructors):

According to the Tests of Between-Subjects Effects, there is a significant main effect of student on the average exam scores. $p < 0.01$.

Conclusion: There is a significant main effect of instructors on the average exam scores, indicating significant differences in overall performance between student groups.

		Statistic	df1	df2	Sig.
EXAM1	Based on Mean	1.516	4	20	.236
	Based on Median	.800	4	20	.539
	Based on Median and with adjusted df	.800	4	14.215	.545
	Based on trimmed mean	1.513	4	20	.236
EXAM2	Based on Mean	2.598	4	20	.067
	Based on Median	1.259	4	20	.319
	Based on Median and with adjusted df	1.259	4	13.843	.332
	Based on trimmed mean	2.572	4	20	.069
EXAM3	Based on Mean	2.033	4	20	.128
	Based on Median	1.676	4	20	.195
	Based on Median and with adjusted df	1.676	4	14.693	.209
	Based on trimmed mean	2.066	4	20	.124
EXAM4	Based on Mean	1.263	4	20	.317
	Based on Median	.435	4	20	.782
	Based on Median and with adjusted df	.435	4	16.945	.782
	Based on trimmed mean	1.211	4	20	.337
EXAM5	Based on Mean	1.811	4	20	.166
	Based on Median	.595	4	20	.670
	Based on Median and with adjusted df	.595	4	10.169	.674
	Based on trimmed mean	1.692	4	20	.191

Tests the null hypothesis that the error variance of the dependent variable is equal across

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Residual for EXAM1	.150	25	.153	.942	25	.163
Residual for EXAM2	.133	25	.200*	.966	25	.545
Residual for EXAM3	.140	25	.200*	.973	25	.712
Residual for EXAM4	.098	25	.200*	.967	25	.581
Residual for EXAM5	.120	25	.200*	.924	25	.064

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Test of Residuals:

The p-values> 0.01The residuals are all normally distributed.

MEASURE_1

Duncan[a,b]

		Subset			
STUDENT	N	1	2	3	4
1	5	40.64			
2	5		50.44		
3	5			60.32	
4	5			64.44	
5	5				71.36
Sig.		1.000	1.000	.222	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 26.769.

a. Uses Harmonic Mean Sample Size = 5.000.

b. Alpha = .05.

Ranking of Instructors:

1. Kindness

2. Goodness
3. Peace
4. Joy
5. Love

Therefore, the best three instructors are Kindness, Goodness, and Peace.