

Univariate Two-Way Repeated Measures ANOVA
Maxwell & Delaney

Both Factors Repeated

A Factor: Phase

B Factor: Time

Dependent Variable: % of positive drug screens

“*Subject*” is treated as an additional, random factor.

	Phase I		Phase II		Phase III	
Subject	Day	Night	Day	Night	Day	Night
<i>S1</i>	30	40	10	20	10	10
<i>S2</i>	30	40	20	20	20	40
<i>S3</i>	40	30	20	30	30	20
<i>S4</i>	50	40	40	50	40	40
<i>S5</i>	10	20	10	30	10	20
<i>S6</i>	30	40	10	20	10	10
<i>S7</i>	30	40	20	20	20	40
<i>S8</i>	40	30	20	30	30	20
<i>S9</i>	50	40	40	50	40	40
<i>S10</i>	10	20	10	30	10	20

Test of A Factor: Phase

Null Hypothesis:**Alternative Hypothesis:**

$$F_A = \frac{bn \sum_{j=1}^a (\bar{Y}_j - \bar{Y})^2 / (a-1)}{b \sum_{j=1}^a \sum_{i=1}^n (\bar{Y}_{ij} - \bar{Y}_i - \bar{Y}_j + \bar{Y})^2 / ((n-1)(a-1))} = \frac{MS_A}{MS_{AS}}$$

Numerator $df = (a - 1)$

Denominator $df = (n - 1)(a - 1)$

Assumptions of the F_A Test

1. The residuals are independent.
2. The residuals are normally distributed.
3. Homogeneity of treatment difference variances among the levels of the A factor.

Compound Symmetry: Variance/Covariance Matrix

	Phase 1	Phase 2	Phase 3
Phase 1	100	80	80
Phase 2	80	100	80
Phase 3	80	80	100

Use the Greenhouse-Geiser adjusted degrees of freedom or the Hyunh-Feldt adjusted degrees of freedom to compensate for the sphericity violation.

Test of B Factor: Time

Null Hypothesis:**Alternative Hypothesis:**

$$F_B = \frac{an \sum_{k=1}^b (\bar{Y}_k - \bar{Y})^2 / (b-1)}{a \sum_{k=1}^b \sum_{i=1}^n (\bar{Y}_{ik} - \bar{Y}_i - \bar{Y}_k + \bar{Y})^2 / ((n-1)(b-1))} = \frac{MS_B}{MS_{BS}}$$

Numerator $df = (b - 1)$ Denominator $df = (n - 1)(b - 1)$ **Assumptions of the F_B Test**

1. The residuals are independent.
2. The residuals are normally distributed.
3. Homogeneity of treatment difference variances among the levels of the B factor.

Compound Symmetry: Variance/Covariance Matrix

	Day	Night
Day	75	40
Night	40	75

Generally, use the Greenhouse-Geiser adjusted degrees of freedom or the Hyunh-Feldt adjusted degrees of freedom to compensate for the sphericity violation. With only 2 levels, the sphericity assumption is valid so the degrees of freedom are not adjusted.

Test of AB Interaction: Phase*Time

Null Hypothesis:

Alternative Hypothesis:

$$F_{AB} = \frac{n \sum_{j=1}^{a+} \sum_{k=1}^b (\bar{Y}_{jk} - \bar{Y}_j - \bar{Y}_k + \bar{Y})^2 / ((a-1)(b-1))}{\sum_{k=1}^b \sum_{j=1}^a \sum_{i=1}^n (\bar{Y}_{ijk} - \bar{Y}_{ij} - \bar{Y}_{ik} - \bar{Y}_{jk} + \bar{Y}_i + \bar{Y}_j + \bar{Y}_k - \bar{Y})^2 / ((n-1)(a-1)(b-1))} = \frac{MS_{AB}}{MS_{ABS}}$$

Numerator $df = (a - 1)(b - 1)$

Denominator $df = (n - 1)(a - 1)(b - 1)$

Assumptions of the F_{AB} Test

1. The residuals are independent.
2. The residuals are normally distributed.
3. Homogeneity of treatment difference variances...

$$\begin{aligned} & \sigma^2 [(B1 - B2)@ A1 - (B1 - B2)@ A2] \\ & = \sigma^2 [(B1 - B2)@ A1 - (B1 - B2)@ A3] \\ & = \sigma^2 [(B1 - B2)@ A2 - (B1 - B2)@ A3] \end{aligned}$$

Compound Symmetry: Variance/Covariance Matrix

	Phase 1 Day - Night	Phase 2 Day - Night	Phase 3 Day - Night
Phase 1 Day - Night			
Phase 2 Day - Night			
Phase 3 Day - Night			

Use the Greenhouse-Geiser adjusted degrees of freedom or the Hyunh-Feldt adjusted degrees of freedom to compensate for the sphericity violation.

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures

Within-Subject Factor Name: Phase

Number of Levels: 3

√ ADD

Within-Subject Factor Name: Time

Number of Levels: 2

√ ADD

√ Define

Within-Subjects Variables (PHASE, TIME):

P1DAY(1,1)

P1NIGHT(1,2)

P2DAY(2,1)

P2NIGHT(2,2)

P3DAY(3,1)

P3NIGHT(3,2)

√Options

Display Means for: PHASE, TIME, PHASE*TIME

√Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

PHASE	TIME	Dependent Variable
1	1	P1DAY
	2	P1NIGHT
2	1	P2DAY
	2	P2NIGHT
3	1	P3DAY
	2	P3NIGHT

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
PHASE	Pillai's Trace	.523	4.392 ^a	2.000	8.000	.052	.523
	Wilks' Lambda	.477	4.392 ^a	2.000	8.000	.052	.523
	Hotelling's Trace	1.098	4.392 ^a	2.000	8.000	.052	.523
	Roy's Largest Root	1.098	4.392 ^a	2.000	8.000	.052	.523
TIME	Pillai's Trace	.427	6.698 ^a	1.000	9.000	.029	.427
	Wilks' Lambda	.573	6.698 ^a	1.000	9.000	.029	.427
	Hotelling's Trace	.744	6.698 ^a	1.000	9.000	.029	.427
	Roy's Largest Root	.744	6.698 ^a	1.000	9.000	.029	.427
PHASE * TIME	Pillai's Trace	.345	2.105 ^a	2.000	8.000	.184	.345
	Wilks' Lambda	.655	2.105 ^a	2.000	8.000	.184	.345
	Hotelling's Trace	.526	2.105 ^a	2.000	8.000	.184	.345
	Roy's Largest Root	.526	2.105 ^a	2.000	8.000	.184	.345

a. Exact statistic

b. Design: Intercept

Within Subjects Design: PHASE + TIME + PHASE * TIME

Mauchly's Test of Sphericity^b

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 PHASE	.764	2.157	2	.340	.809	.960	.500
TIME	1.000	.000	0	.	1.000	1.000	1.000
PHASE * TIME	.645	3.507	2	.173	.738	.848	.500

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

a. 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.

b. Design: Intercept

Within Subjects Design: PHASE + TIME + PHASE * TIME

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PHASE	Sphericity Assumed	973.333	2	486.667	6.773	.006	.429
	Greenhouse-Geisser	973.333	1.618	601.700	6.773	.011	.429
	Huynh-Feldt	973.333	1.920	506.864	6.773	.007	.429
	Lower-bound	973.333	1.000	973.333	6.773	.029	.429
Error(PHASE)	Sphericity Assumed	1293.333	18	71.852			
	Greenhouse-Geisser	1293.333	14.559	88.835			
	Huynh-Feldt	1293.333	17.283	74.834			
	Lower-bound	1293.333	9.000	143.704			
TIME	Sphericity Assumed	426.667	1	426.667	6.698	.029	.427
	Greenhouse-Geisser	426.667	1.000	426.667	6.698	.029	.427
	Huynh-Feldt	426.667	1.000	426.667	6.698	.029	.427
	Lower-bound	426.667	1.000	426.667	6.698	.029	.427
Error(TIME)	Sphericity Assumed	573.333	9	63.704			
	Greenhouse-Geisser	573.333	9.000	63.704			
	Huynh-Feldt	573.333	9.000	63.704			
	Lower-bound	573.333	9.000	63.704			
PHASE * TIME	Sphericity Assumed	173.333	2	86.667	2.489	.111	.217
	Greenhouse-Geisser	173.333	1.476	117.426	2.489	.130	.217
	Huynh-Feldt	173.333	1.696	102.197	2.489	.122	.217
	Lower-bound	173.333	1.000	173.333	2.489	.149	.217
Error(PHASE*TIME)	Sphericity Assumed	626.667	18	34.815			
	Greenhouse-Geisser	626.667	13.285	47.171			
	Huynh-Feldt	626.667	15.265	41.053			
	Lower-bound	626.667	9.000	69.630			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PHASE	Linear	810.000	1	810.000	9.851	.012	.523
	Quadratic	163.333	1	163.333	2.657	.138	.228
Error(PHASE)	Linear	740.000	9	82.222			
	Quadratic	553.333	9	61.481			
TIME	dimension3 Linear	426.667	1	426.667	6.698	.029	.427
Error(TIME)	dimension3 Linear	573.333	9	63.704			
PHASE * TIME	Linear	Linear	10.000	1	10.000	.643	.443
	Quadratic	Linear	163.333	1	163.333	3.021	.116
Error(PHASE*TIME)	Linear	Linear	140.000	9	15.556		
	Quadratic	Linear	486.667	9	54.074		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	44826.667	1	44826.667	79.003	.000	.898
Error	5106.667	9	567.407			

Estimated Marginal Means

1. PHASE

Measure: MEASURE_1

PHASE	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	33.000	3.266	25.612	40.388
2	25.000	3.496	17.091	32.909
3	24.000	3.559	15.949	32.051

2. TIME

Measure: MEASURE_1

TIME	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	24.667	3.823	16.018	33.315
2	30.000	2.534	24.268	35.732

3. PHASE * TIME

Measure: MEASURE_1

PHASE	TIME	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	32.000	4.422	21.996	42.004
	2	34.000	2.667	27.968	40.032
2	1	20.000	3.651	11.740	28.260
	2	30.000	3.651	21.740	38.260
3	1	22.000	3.887	13.206	30.794
	2	26.000	4.000	16.951	35.049

Follow-up Tests When the interaction was not significant...

Pairwise Comparisons Among the Levels of *A* Factor.

- For each level of *A*, create a new variable in SPSS that is the average.
- Use the *t* test for dependent samples to conduct the pairwise comparisons.
- Use a Bonferroni adjusted alpha level to determine the significance of the *t* tests.

SPSS Instructions

→Transform→Compute Variable
Target Variable: PHASE1
Numeric Expression: MEAN(P1DAY,P1NIGHT)
→Transform→Compute Variable
Target Variable: PHASE2
Numeric Expression: MEAN(P2DAY,P2NIGHT)
→Transform→Compute Variable
Target Variable: PHASE3
Numeric Expression: MEAN(P3DAY,P3NIGHT)

Pairwise Comparisons Among the Levels of *B* Factor.

- For each level of *B*, create a new variable in SPSS that is the average.
- Use the *t* test for dependent samples to conduct the pairwise comparisons.
- Use a Bonferroni adjusted alpha level to determine the significance of the *t* tests.

Since *B* only has 2 levels, pairwise comparisons are unnecessary.

SPSS Instructions

→ Analyze → Compare Means → Paired Samples T Test

Paired Variables:

Pair 1: PHASE1 PHASE2

Pair 2: PHASE1 PHASE3

Pair 3: PHASE2 PHASE3

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PHASE1	33.0000	10	10.32796	3.26599
	PHASE2	25.0000	10	11.05542	3.49603
Pair 2	PHASE1	33.0000	10	10.32796	3.26599
	PHASE3	24.0000	10	11.25463	3.55903
Pair 3	PHASE2	25.0000	10	11.05542	3.49603
	PHASE3	24.0000	10	11.25463	3.55903

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PHASE1 & PHASE2	10	.584	.076
Pair 2	PHASE1 & PHASE3	10	.650	.042
Pair 3	PHASE2 & PHASE3	10	.848	.002

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PHASE1 - PHASE2	8.0000	9.77525	3.09121	1.0072	14.9928	2.588	9	.029
Pair 2	PHASE1 - PHASE3	9.0000	9.06765	2.86744	2.5134	15.4866	3.139	9	.012
Pair 3	PHASE2 - PHASE3	1.0000	6.14636	1.94365	-3.3968	5.3968	.514	9	.619

Two-Way Repeated Measures ANOVA (Both Within-Subjects Factors)
--Example of Significant Interaction

Subject	Phase I		Phase II		Phase III	
	Day	Night	Day	Night	Day	Night
<i>S1</i>	30	40	10	20	10	10
<i>S2</i>	30	40	20	20	20	40
<i>S3</i>	40	30	20	30	30	20
<i>S4</i>	50	40	40	50	40	40
<i>S5</i>	10	20	10	30	10	20
<i>S6</i>	30	40	10	20	10	10
<i>S7</i>	30	40	20	20	20	40
<i>S8</i>	40	30	20	30	30	20
<i>S9</i>	50	40	40	50	40	40
<i>S10</i>	10	20	10	30	10	20
<i>S11</i>	30	40	10	20	10	10
<i>S12</i>	30	40	20	20	20	40
<i>S13</i>	40	30	20	30	30	20
<i>S14</i>	50	40	40	50	40	40
<i>S15</i>	10	20	10	30	10	20
<i>S16</i>	30	40	10	20	10	10
<i>S17</i>	30	40	20	20	20	40
<i>S18</i>	40	30	20	30	30	20
<i>S19</i>	50	40	40	50	40	40
<i>S20</i>	10	20	10	30	10	20
<i>S21</i>	30	40	10	20	10	10
<i>S22</i>	30	40	20	20	20	40
<i>S23</i>	40	30	20	30	30	20
<i>S24</i>	50	40	40	50	40	40
<i>S25</i>	10	20	10	30	10	20
<i>S26</i>	30	40	10	20	10	10
<i>S27</i>	30	40	20	20	20	40
<i>S28</i>	40	30	20	30	30	20
<i>S29</i>	50	40	40	50	40	40
<i>S30</i>	10	20	10	30	10	20

SPSS Instructions
 →Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: Phase
 Number of Levels: 3
 √ ADD
 Within-Subject Factor Name: Time
 Number of Levels: 2
 √ ADD
 √ Define
 Within-Subjects Variables (PHASE, TIME):
 P1DAY(1,1)
 P1NIGHT(1,2)
 P2DAY(2,1)
 P2NIGHT(2,2)
 P3DAY(3,1)
 P3NIGHT(3,2)
 √Options
 Display Means for: PHASE, TIME, PHASE*TIME
 √Estimates of Effect Size

General Linear Model
Within-Subjects Factors
 Measure: MEASURE_1

PHASE	TIME	Dependent Variable
1	1	P1DAY
	2	P1NIGHT
2	1	P2DAY
	2	P2NIGHT
3	1	P3DAY
	2	P3NIGHT

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
PHASE	Pillai's Trace	.523	15.374 ^a	2.000	28.000	.000	.523
	Wilks' Lambda	.477	15.374 ^a	2.000	28.000	.000	.523
	Hotelling's Trace	1.098	15.374 ^a	2.000	28.000	.000	.523
	Roy's Largest Root	1.098	15.374 ^a	2.000	28.000	.000	.523
TIME	Pillai's Trace	.427	21.581 ^a	1.000	29.000	.000	.427
	Wilks' Lambda	.573	21.581 ^a	1.000	29.000	.000	.427
	Hotelling's Trace	.744	21.581 ^a	1.000	29.000	.000	.427
	Roy's Largest Root	.744	21.581 ^a	1.000	29.000	.000	.427
PHASE * TIME	Pillai's Trace	.345	7.368 ^a	2.000	28.000	.003	.345
	Wilks' Lambda	.655	7.368 ^a	2.000	28.000	.003	.345
	Hotelling's Trace	.526	7.368 ^a	2.000	28.000	.003	.345
	Roy's Largest Root	.526	7.368 ^a	2.000	28.000	.003	.345

a. Exact statistic

b. Design: Intercept

Within Subjects Design: PHASE + TIME + PHASE * TIME

Mauchly's Test of Sphericity^b

Measure: MEASURE_1

Within Subjects Effect		Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
						Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1	PHASE	.764	7.551	2	.023	.809	.850	.500
	TIME	1.000	.000	0	.	1.000	1.000	1.000
	PHASE *	.645	12.274	2	.002	.738	.768	.500
	TIME							

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

a. 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.

b. Design: Intercept

Within Subjects Design: PHASE + TIME + PHASE * TIME

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PHASE	Sphericity Assumed	2920.000	2	1460.000	21.825	.000	.429
	Greenhouse-Geisser	2920.000	1.618	1805.099	21.825	.000	.429
	Huynh-Feldt	2920.000	1.699	1718.416	21.825	.000	.429
	Lower-bound	2920.000	1.000	2920.000	21.825	.000	.429
Error(PHASE)	Sphericity Assumed	3880.000	58	66.897			
	Greenhouse-Geisser	3880.000	46.912	82.709			
	Huynh-Feldt	3880.000	49.278	78.737			
	Lower-bound	3880.000	29.000	133.793			
TIME	Sphericity Assumed	1280.000	1	1280.000	21.581	.000	.427
	Greenhouse-Geisser	1280.000	1.000	1280.000	21.581	.000	.427
	Huynh-Feldt	1280.000	1.000	1280.000	21.581	.000	.427
	Lower-bound	1280.000	1.000	1280.000	21.581	.000	.427
Error(TIME)	Sphericity Assumed	1720.000	29	59.310			
	Greenhouse-Geisser	1720.000	29.000	59.310			
	Huynh-Feldt	1720.000	29.000	59.310			
	Lower-bound	1720.000	29.000	59.310			
PHASE * TIME	Sphericity Assumed	520.000	2	260.000	8.021	.001	.217
	Greenhouse-Geisser	520.000	1.476	352.277	8.021	.003	.217
	Huynh-Feldt	520.000	1.536	338.489	8.021	.002	.217
	Lower-bound	520.000	1.000	520.000	8.021	.008	.217
Error(PHASE*TIME)	Sphericity Assumed	1880.000	58	32.414			
	Greenhouse-Geisser	1880.000	42.807	43.918			
	Huynh-Feldt	1880.000	44.551	42.199			
	Lower-bound	1880.000	29.000	64.828			

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	TIME	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	
PHASE	Linear	2430.000	1	2430.000	31.743	.000	.523	
	Quadratic	490.000	1	490.000	8.560	.007	.228	
Error(PHASE)	Linear	2220.000	29	76.552				
	Quadratic	1660.000	29	57.241				
TIME	dimension3 Linear	1280.000	1	1280.000	21.581	.000	.427	
Error(TIME)	dimension3 Linear	1720.000	29	59.310				
PHASE * TIME	Linear	Linear	30.000	1	30.000	2.071	.161	.067
	Quadratic	Linear	490.000	1	490.000	9.733	.004	.251
Error(PHASE*TIME)	Linear	Linear	420.000	29	14.483			
	Quadratic	Linear	1460.000	29	50.345			

Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	134480.000	1	134480.000	254.564	.000	.898
Error	15320.000	29	528.276			

Estimated Marginal Means

1. PHASE

Measure:MEASURE_1

PHASE	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	33.000	1.819	29.279	36.721
2	25.000	1.948	21.017	28.983
3	24.000	1.983	19.945	28.055

2. TIME

Measure:MEASURE_1

TIME	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	24.667	2.130	20.311	29.023
2	30.000	1.412	27.113	32.887

3. PHASE * TIME

Measure:MEASURE_1

PHASE	TIME	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	32.000	2.464	26.962	37.038
	2	34.000	1.486	30.962	37.038
2	1	20.000	2.034	15.840	24.160
	2	30.000	2.034	25.840	34.160
3	1	22.000	2.166	17.571	26.429
	2	26.000	2.228	21.443	30.557

Follow-up Tests When the Interaction is Significant

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures

Within-Subject Factor Name: Phase

Number of Levels: 3

√ ADD

√ Define

Within-Subjects Variables (PHASE):

P1DAY(1)

P2DAY(2)

P3DAY(3)

√Options

Display Means for: PHASE

√Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure:MEASURE_1

PHASE	Dependent Variable
1	P1DAY
2	P2DAY
3	P3DAY

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
PHASE	Pillai's Trace	.733	38.500 ^a	2.000	28.000	.000	.733
	Wilks' Lambda	.267	38.500 ^a	2.000	28.000	.000	.733
	Hotelling's Trace	2.750	38.500 ^a	2.000	28.000	.000	.733
	Roy's Largest Root	2.750	38.500 ^a	2.000	28.000	.000	.733

a. Exact statistic

b. Design: Intercept

Within Subjects Design: PHASE

Mauchly's Test of Sphericity^b

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 PHASE	.612	13.737	2	.001	.721	.748	.500

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

a. 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.

b. Design: Intercept

Within Subjects Design: PHASE

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PHASE	Sphericity Assumed	2480.000	2	1240.000	64.214	.000	.689
	Greenhouse-Geisser	2480.000	1.441	1720.816	64.214	.000	.689
	Huynh-Feldt	2480.000	1.496	1657.461	64.214	.000	.689
	Lower-bound	2480.000	1.000	2480.000	64.214	.000	.689
Error(PHASE)	Sphericity Assumed	1120.000	58	19.310			
	Greenhouse-Geisser	1120.000	41.794	26.798			
	Huynh-Feldt	1120.000	43.392	25.811			
	Lower-bound	1120.000	29.000	38.621			

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	PHASE	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PHASE	Linear	1500.000	1	1500.000	72.500	.000	.714
	Quadratic	980.000	1	980.000	54.654	.000	.653
Error(PHASE)	Linear	600.000	29	20.690			
	Quadratic	520.000	29	17.931			

Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	54760.000	1	54760.000	134.125	.000	.822
Error	11840.000	29	408.276			

Estimated Marginal Means

PHASE

Measure:MEASURE_1

PHASE	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	32.000	2.464	26.962	37.038
2	20.000	2.034	15.840	24.160
3	22.000	2.166	17.571	26.429

SPSS Instructions

→ Analyze → Compare Means → Paired Samples T Test

Paired Variables:

Pair 1: P1DAY P2DAY

Pair 2: P1DAY P3DAY

Pair 3: P2DAY P3DAY

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	P1DAY	32.0000	30	13.49329	2.46353
	P2DAY	20.0000	30	11.14172	2.03419
Pair 2	P1DAY	32.0000	30	13.49329	2.46353
	P3DAY	22.0000	30	11.86127	2.16556
Pair 3	P2DAY	20.0000	30	11.14172	2.03419
	P3DAY	22.0000	30	11.86127	2.16556

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	P1DAY & P2DAY	30	.826	.000
Pair 2	P1DAY & P3DAY	30	.879	.000
Pair 3	P2DAY & P3DAY	30	.939	.000

Paired Samples Test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	P1DAY - P2DAY	12.00000	7.61124	1.38962	9.15791	14.84209	8.635	29	.000
Pair 2	P1DAY - P3DAY	10.00000	6.43268	1.17444	7.59800	12.40200	8.515	29	.000
Pair 3	P2DAY - P3DAY	-2.00000	4.06838	.74278	-3.51916	-.48084	-2.693	29	.012

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: Phase
 Number of Levels: 3
 ✓ ADD
 ✓ Define
 Within-Subjects Variables (PHASE):
 P1NIGHT(1)
 P2NIGHT(2)
 P3NIGHT(3)
 ✓Options
 Display Means for: PHASE
 ✓Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure:MEASURE 1

PHASE	Dependent Variable
1	P1NIGHT
2	P2NIGHT
3	P3NIGHT

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
PHASE	Pillai's Trace	.325	6.741 ^a	2.000	28.000	.004	.325
	Wilks' Lambda	.675	6.741 ^a	2.000	28.000	.004	.325
	Hotelling's Trace	.481	6.741 ^a	2.000	28.000	.004	.325
	Roy's Largest Root	.481	6.741 ^a	2.000	28.000	.004	.325

a. Exact statistic

b. Design: Intercept

Within Subjects Design: PHASE

Mauchly's Test of Sphericity^b

Measure:MEASURE 1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 PHASE	.963	1.052	2	.591	.964	1.000	.500

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

a. 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.

b. Design: Intercept

Within Subjects Design: PHASE

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PHASE	Sphericity Assumed	960.000	2	480.000	6.000	.004	.171
	Greenhouse-Geisser	960.000	1.929	497.693	6.000	.005	.171
	Huynh-Feldt	960.000	2.000	480.000	6.000	.004	.171
	Lower-bound	960.000	1.000	960.000	6.000	.021	.171
Error(PHASE)	Sphericity Assumed	4640.000	58	80.000			
	Greenhouse-Geisser	4640.000	55.938	82.949			
	Huynh-Feldt	4640.000	58.000	80.000			
	Lower-bound	4640.000	29.000	160.000			

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	PHASE	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PHASE	Linear	960.000	1	960.000	13.647	.001	.320
	Quadratic	.000	1	.000	.000	1.000	.000
Error(PHASE)	Linear	2040.000	29	70.345			
	Quadratic	2600.000	29	89.655			

Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	81000.000	1	81000.000	451.731	.000	.940
Error	5200.000	29	179.310			

Estimated Marginal Means

PHASE

Measure:MEASURE_1

PHASE	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	34.000	1.486	30.962	37.038
2	30.000	2.034	25.840	34.160
3	26.000	2.228	21.443	30.557

SPSS Instructions

→ Analyze → Compare Means → Paired Samples T Test

Paired Variables:

Pair 1: P1NIGHT P2NIGHT

Pair 2: P1NIGHT P3NIGHT

Pair 3: P2NIGHT P3NIGHT

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	P1NIGHT	34.0000	30	8.13676	1.48556
	P2NIGHT	30.0000	30	11.14172	2.03419
Pair 2	P1NIGHT	34.0000	30	8.13676	1.48556
	P3NIGHT	26.0000	30	12.20514	2.22834
Pair 3	P2NIGHT	30.0000	30	11.14172	2.03419
	P3NIGHT	26.0000	30	12.20514	2.22834

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	P1NIGHT & P2NIGHT	30	.000	1.000
Pair 2	P1NIGHT & P3NIGHT	30	.375	.041
Pair 3	P2NIGHT & P3NIGHT	30	.456	.011

Paired Samples Test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	P1NIGHT - P2NIGHT	4.00000	13.79655	2.51889	-1.15172	9.15172	1.588	29	.123
Pair 2	P1NIGHT - P3NIGHT	8.00000	11.86127	2.16556	3.57093	12.42907	3.694	29	.001
Pair 3	P2NIGHT - P3NIGHT	4.00000	12.20514	2.22834	-.55748	8.55748	1.795	29	.083

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: TIME
 Number of Levels: 2
 √ ADD
 √ Define
 Within-Subjects Variables (TIME):
 P1DAY(1)
 P1NIGHT(2)
 √Options
 Display Means for: TIME
 √Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure:MEASURE_1

TIME	Dependent Variable
1	P1DAY
2	P1NIGHT

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
TIME	Pillai's Trace	.040	1.208 ^a	1.000	29.000	.281	.040
	Wilks' Lambda	.960	1.208 ^a	1.000	29.000	.281	.040
	Hotelling's Trace	.042	1.208 ^a	1.000	29.000	.281	.040
	Roy's Largest Root	.042	1.208 ^a	1.000	29.000	.281	.040

a. Exact statistic

b. Design: Intercept

Within Subjects Design: TIME

Mauchly's Test of Sphericity^b

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 TIME	1.000	.000	0	.	1.000	1.000	1.000

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

a. 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.

b. Design: Intercept

Within Subjects Design: TIME

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Sphericity Assumed	60.000	1	60.000	1.208	.281	.040
	Greenhouse-Geisser	60.000	1.000	60.000	1.208	.281	.040
	Huynh-Feldt	60.000	1.000	60.000	1.208	.281	.040
	Lower-bound	60.000	1.000	60.000	1.208	.281	.040
Error(TIME)	Sphericity Assumed	1440.000	29	49.655			
	Greenhouse-Geisser	1440.000	29.000	49.655			
	Huynh-Feldt	1440.000	29.000	49.655			
	Lower-bound	1440.000	29.000	49.655			

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	TIME	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Linear	60.000	1	60.000	1.208	.281	.040
Error(TIME)	Linear	1440.000	29	49.655			

Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	65340.000	1	65340.000	328.969	.000	.919
Error	5760.000	29	198.621			

Estimated Marginal Means

TIME

Measure:MEASURE_1

TIME	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	32.000	2.464	26.962	37.038
2	34.000	1.486	30.962	37.038

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: TIME
 Number of Levels: 2
 √ ADD
 √ Define
 Within-Subjects Variables (TIME):
 P2DAY(1)
 P2NIGHT(2)
 √Options
 Display Means for: TIME
 √Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure:MEASURE_1

TIME	Dependent Variable
1	P2DAY
2	P2NIGHT

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
TIME	Pillai's Trace	.714	72.500 ^a	1.000	29.000	.000	.714
	Wilks' Lambda	.286	72.500 ^a	1.000	29.000	.000	.714
	Hotelling's Trace	2.500	72.500 ^a	1.000	29.000	.000	.714
	Roy's Largest Root	2.500	72.500 ^a	1.000	29.000	.000	.714

a. Exact statistic

b. Design: Intercept

Within Subjects Design: TIME

Mauchly's Test of Sphericity^b

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 TIME	1.000	.000	0	.	1.000	1.000	1.000

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

a. 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.

b. Design: Intercept

Within Subjects Design: TIME

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Sphericity Assumed	1500.000	1	1500.000	72.500	.000	.714
	Greenhouse-Geisser	1500.000	1.000	1500.000	72.500	.000	.714
	Huynh-Feldt	1500.000	1.000	1500.000	72.500	.000	.714
	Lower-bound	1500.000	1.000	1500.000	72.500	.000	.714
Error(TIME)	Sphericity Assumed	600.000	29	20.690			
	Greenhouse-Geisser	600.000	29.000	20.690			
	Huynh-Feldt	600.000	29.000	20.690			
	Lower-bound	600.000	29.000	20.690			

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	TIME	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Linear	1500.000	1	1500.000	72.500	.000	.714
Error(TIME)	Linear	600.000	29	20.690			

Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	37500.000	1	37500.000	164.773	.000	.850
Error	6600.000	29	227.586			

Estimated Marginal Means

TIME

Measure:MEASURE_1

TIME	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	20.000	2.034	15.840	24.160
2	30.000	2.034	25.840	34.160

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: TIME
 Number of Levels: 2
 √ ADD
 √ Define
 Within-Subjects Variables (TIME):
 P3DAY(1)
 P3NIGHT(2)
 √Options
 Display Means for: TIME
 √Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure:MEASURE_1

TIME	Dependent Variable
1	P3DAY
2	P3NIGHT

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
TIME	Pillai's Trace	.133	4.462 ^a	1.000	29.000	.043	.133
	Wilks' Lambda	.867	4.462 ^a	1.000	29.000	.043	.133
	Hotelling's Trace	.154	4.462 ^a	1.000	29.000	.043	.133
	Roy's Largest Root	.154	4.462 ^a	1.000	29.000	.043	.133

a. Exact statistic

b. Design: Intercept

Within Subjects Design: TIME

Mauchly's Test of Sphericity^b

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 TIME	1.000	.000	0	.	1.000	1.000	1.000

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

a. 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.

b. Design: Intercept

Within Subjects Design: TIME

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Sphericity Assumed	240.000	1	240.000	4.462	.043	.133
	Greenhouse-Geisser	240.000	1.000	240.000	4.462	.043	.133
	Huynh-Feldt	240.000	1.000	240.000	4.462	.043	.133
	Lower-bound	240.000	1.000	240.000	4.462	.043	.133
Error(TIME)	Sphericity Assumed	1560.000	29	53.793			
	Greenhouse-Geisser	1560.000	29.000	53.793			
	Huynh-Feldt	1560.000	29.000	53.793			
	Lower-bound	1560.000	29.000	53.793			

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	TIME	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Linear	240.000	1	240.000	4.462	.043	.133
Error(TIME)	Linear	1560.000	29	53.793			

Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	34560.000	1	34560.000	146.526	.000	.835
Error	6840.000	29	235.862			

Estimated Marginal Means

TIME

Measure:MEASURE_1

TIME	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	22.000	2.166	17.571	26.429
2	26.000	2.228	21.443	30.557

One Factor Repeated, One Factor Between Subjects

A Factor: Gender

B Factor: Grade Level

Dependent Variable: Number of Questions Per Week with Teachers

“*Subject*” is treated as an additional, random factor.

Number of Questions Per Week with Teachers

Gender	Subject	First Grade	Fourth Grade	Seventh Grade
Female	1	4.00	2.00	5.00
Female	2	3.00	3.00	6.00
Female	3	2.00	2.00	10.00
Female	4	7.00	6.00	8.00
Female	5	3.00	10.00	6.00
Female	6	4.00	6.00	4.00
Female	7	2.00	3.00	14.00
Female	8	5.00	8.00	10.00
Female	9	4.00	11.00	11.00
Female	10	6.00	12.00	12.00
Female	11	6.00	4.00	13.00
Female	12	5.00	4.00	11.00
Female	13	4.00	5.00	12.00
Female	14	3.00	8.00	9.00
Female	15	6.00	7.00	15.00
Male	16	5.00	7.00	16.00
Male	17	4.00	2.00	10.00
Male	18	6.00	10.00	12.00
Male	19	5.00	8.00	9.00
Male	20	12.00	7.00	12.00
Male	21	1.00	5.00	10.00
Male	22	7.00	9.00	6.00
Male	23	6.00	3.00	16.00
Male	24	5.00	1.00	7.00
Male	25	5.00	6.00	12.00
Male	26	3.00	7.00	6.00
Male	27	5.00	7.00	15.00
Male	28	3.00	8.00	15.00
Male	29	7.00	12.00	7.00
Male	30	3.00	5.00	12.00

Test of A Factor (Between Subjects): Gender

Null Hypothesis:**Alternative Hypothesis:**

$$F_A = \frac{bn \sum_{j=1}^a (\bar{Y}_j - \bar{Y})^2 / (a-1)}{b \sum_{j=1}^a \sum_{i=1}^n (\bar{Y}_{ij} - \bar{Y}_j)^2 / (N-a)} = \frac{MS_A}{MS_{Subjects(A)}}$$

Numerator $df = a - 1$

Denominator $df = N - a$

Assumptions of the F_A Test

1. The residuals are independent.
2. The residuals are normally distributed.
3. Equal population variances among the levels of the A factor.

Variance/Covariance Matrix

	Females	Males
Females	25	0
Males	0	25

Pairwise Comparisons for Independent Groups

- Tukey
- Scheffe
- Bonferroni
- Sidak
- Games-Howell

Test of B Factor: Grade Level

Null Hypothesis:

Alternative Hypothesis:

$$F_B = \frac{an \sum_{k=1}^b (\bar{Y}_k - \bar{Y})^2 / (b-1)}{\sum_{k=1}^b \sum_{j=1}^a \sum_{i=1}^n (Y_{ijk} - \bar{Y}_{ij} - \bar{Y}_{jk} + \bar{Y}_j)^2 / ((N-a)(b-1))} = \frac{MS_B}{MS_{BS(A)}}$$

Numerator $df = (b - 1)$
 Denominator $df = (N - a)(b - 1)$

Assumptions of the F_B Test

1. The residuals are independent.
2. The residuals are normally distributed.
3. Sphericity: Homogeneity of treatment difference variances among the levels of the B factor are equal for each level of the A factor.

Compound Symmetry: Variance/Covariance Matrix

Females		Males
	First Fourth Seventh	
First		
Fourth		
Seventh		
=		
	First Fourth Seventh	
First		
Fourth		
Seventh		

Use the Greenhouse-Geiser adjusted degrees of freedom or the Hyunh-Feldt adjusted degrees of freedom to compensate for the sphericity violation.

Pairwise Comparisons for Repeated Factor

T test for dependent samples with a Bonferroni or Sidak adjusted alpha level.

Test of AB Interaction: Gender*Grade Level

Null Hypothesis:

Alternative Hypothesis:

$$F_{AB} = \frac{n \sum_{j=1}^{a+} \sum_{k=1}^b (\bar{Y}_{jk} - \bar{Y}_j - \bar{Y}_k + \bar{Y})^2 / ((a-1)(b-1))}{\sum_{k=1}^b \sum_{j=1}^a \sum_{i=1}^n (Y_{ijk} - \bar{Y}_{ij} - \bar{Y}_{jk} + \bar{Y}_j)^2 / ((N-a)(b-1))} = \frac{MS_{AB}}{MS_{BS(A)}}$$

Numerator $df = (a - 1)(b - 1)$
 Denominator $df = (N - a)(b - 1)$

Assumptions of the F_{AB} Test

1. The residuals are independent.
2. The residuals are normally distributed.
3. Sphericity: Homogeneity of treatment difference variances among the levels of the B factor are equal for each level of the A factor.

Compound Symmetry: Variance/Covariance Matrix

Females		Males																																
<table style="border-collapse: collapse; width: 100%;"> <tr> <td style="border: none;"></td> <td style="border: 1px solid black; padding: 5px; text-align: center;">First</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">Fourth</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">Seventh</td> </tr> <tr> <td style="border: none; text-align: right; padding: 5px;">First</td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> </tr> <tr> <td style="border: none; text-align: right; padding: 5px;">Fourth</td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> </tr> <tr> <td style="border: none; text-align: right; padding: 5px;">Seventh</td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> </tr> </table>		First	Fourth	Seventh	First				Fourth				Seventh				=	<table style="border-collapse: collapse; width: 100%;"> <tr> <td style="border: none;"></td> <td style="border: 1px solid black; padding: 5px; text-align: center;">First</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">Fourth</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">Seventh</td> </tr> <tr> <td style="border: none; text-align: right; padding: 5px;">First</td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> </tr> <tr> <td style="border: none; text-align: right; padding: 5px;">Fourth</td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> </tr> <tr> <td style="border: none; text-align: right; padding: 5px;">Seventh</td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> <td style="border: 1px solid black; width: 50px; height: 20px;"></td> </tr> </table>		First	Fourth	Seventh	First				Fourth				Seventh			
	First	Fourth	Seventh																															
First																																		
Fourth																																		
Seventh																																		
	First	Fourth	Seventh																															
First																																		
Fourth																																		
Seventh																																		

Use the Greenhouse-Geiser adjusted degrees of freedom or the Hyunh-Feldt adjusted degrees of freedom to compensate for the sphericity violation.

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: GRADE
 Number of Levels: 3
 ✓ ADD
 ✓ Define
 Within-Subjects Variables (GRADE):
 FIRST(1)
 FOURTH(2)
 SEVENTH(3)
 Between-Subjects Variables:
 GENDER
 ✓Options
 Display Means for: GRADE GENDER GRADE*GENDER
 ✓Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

GRADE	Dependent Variable
1	first
2	fourth
3	seventh

Between-Subjects Factors

	Value Label	N
gender	1.00 Female	15
	2.00 Male	15

Multivariate Tests^b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
GRADE	Pillai's Trace	.705	32.250 ^a	2.000	27.000	.000	.705
	Wilks' Lambda	.295	32.250 ^a	2.000	27.000	.000	.705
	Hotelling's Trace	2.389	32.250 ^a	2.000	27.000	.000	.705
	Roy's Largest Root	2.389	32.250 ^a	2.000	27.000	.000	.705
GRADE * gender	Pillai's Trace	.010	.134 ^a	2.000	27.000	.875	.010
	Wilks' Lambda	.990	.134 ^a	2.000	27.000	.875	.010
	Hotelling's Trace	.010	.134 ^a	2.000	27.000	.875	.010
	Roy's Largest Root	.010	.134 ^a	2.000	27.000	.875	.010

a. Exact statistic

b. Design: Intercept + gender

Within Subjects Design: GRADE

Mauchly's Test of Sphericity^b

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 GRADE	.824	5.230	2	.073	.850	.932	.500

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

a. 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.

b. Design: Intercept + gender

Within Subjects Design: GRADE

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
GRADE	Sphericity Assumed	513.756	2	256.878	32.987	.000	.541
	Greenhouse-Geisser	513.756	1.701	302.117	32.987	.000	.541
	Huynh-Feldt	513.756	1.864	275.658	32.987	.000	.541
	Lower-bound	513.756	1.000	513.756	32.987	.000	.541
GRADE * gender	Sphericity Assumed	2.822	2	1.411	.181	.835	.006
	Greenhouse-Geisser	2.822	1.701	1.660	.181	.800	.006
	Huynh-Feldt	2.822	1.864	1.514	.181	.820	.006
	Lower-bound	2.822	1.000	2.822	.181	.674	.006
Error(GRADE)	Sphericity Assumed	436.089	56	7.787			
	Greenhouse-Geisser	436.089	47.615	9.159			
	Huynh-Feldt	436.089	52.185	8.357			
	Lower-bound	436.089	28.000	15.575			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	GRADE	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
GRADE	Linear	481.667	1	481.667	64.612	.000	.698
	Quadratic	32.089	1	32.089	3.952	.057	.124
GRADE * gender	Linear	.600	1	.600	.080	.779	.003
	Quadratic	2.222	1	2.222	.274	.605	.010
Error(GRADE)	Linear	208.733	28	7.455			
	Quadratic	227.356	28	8.120			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	4551.111	1	4551.111	451.599	.000	.942
gender	16.044	1	16.044	1.592	.217	.054
Error	282.178	28	10.078			

Estimated Marginal Means

1. gender

Measure: MEASURE_1

gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	6.689	.473	5.720	7.658
Male	7.533	.473	6.564	8.503

2. GRADE

Measure: MEASURE_1

GRADE	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	4.700	.379	3.924	5.476
2	6.267	.563	5.113	7.421
3	10.367	.628	9.081	11.652

3. gender * GRADE

Measure: MEASURE_1

gender	GRADE	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Female	1	4.267	.536	3.169	5.365
	2	6.067	.797	4.434	7.699
	3	9.733	.888	7.915	11.552
Male	1	5.133	.536	4.035	6.231
	2	6.467	.797	4.834	8.099
	3	11.000	.888	9.182	12.818

Follow-up Tests When the Interaction Is NOT Significant...

Pairwise Comparisons for the Between-Subjects Factor

The easiest way to obtain these comparisons is to rerun the original analysis and select the Tukey procedure.

Pairwise Comparisons for the Within-Subjects Factor

- Use the t test for dependent samples to conduct the pairwise comparisons.
- Use a Bonferroni or Sidak adjusted alpha level to determine the significance of the t tests.

SPSS Instructions

→ Analyze → Compare Means → Paired Samples T Test

Paired Variables:

Pair 1: FIRST FOURTH

Pair 2: FIRST SEVENTH

Pair 3: FOURTH SEVENTH

T-Test**Paired Samples Statistics**

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 FIRST	4.7000	30	2.08690	.38101
1 FOURTH	6.2667	30	3.03921	.55488
Pair 2 FIRST	4.7000	30	2.08690	.38101
2 SEVENTH	10.3667	30	3.43896	.62787
Pair 3 FOURTH	6.2667	30	3.03921	.55488
3 SEVENTH	10.3667	30	3.43896	.62787

Paired Samples Correlations

	N	Correlation	Sig.
Pair 1 FIRST & FOURTH	30	.285	.127
Pair 2 FIRST & SEVENTH	30	.122	.522
Pair 3 FOURTH & SEVENTH	30	.004	.985

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 FIRST - FOURTH	-1.5667	3.15882	.57672	-2.7462	-.3871	-2.717	29	.011
Pair 2 FIRST - SEVENTH	-5.6667	3.79958	.69370	-7.0855	-4.2479	-8.169	29	.000
Pair 3 FOURTH - SEVENTH	-4.1000	4.58145	.83645	-5.8107	-2.3893	-4.902	29	.000

A Factor: Type of club

B Factor: School status

Dependent Variable: GPA for current status

“*Subject*” is treated as an additional, random factor.

	Subject	Freshman GPA	Sophomore GPA	Junior GPA	Senior GPA
Social Clubs	1	3.01	2.08	3.24	2.90
	2	2.83	2.35	2.38	2.64
	3	2.52	1.90	2.44	3.20
	4	1.97	2.12	2.88	2.93
	5	2.61	1.97	2.22	3.07
	6	2.91	2.31	3.23	2.83
	7	1.46	2.44	3.16	3.32
	8	2.29	2.66	2.43	2.98
	9	1.63	1.95	2.30	2.82
	10	1.90	2.10	2.80	3.01
	11	1.16	2.24	2.55	2.81
	12	1.13	1.95	1.90	3.09
	13	1.74	2.49	2.69	3.32
Sports Clubs	14	2.19	2.02	3.15	2.74
	15	2.24	2.29	2.81	3.22
	16	2.24	2.05	2.84	3.32
	17	2.18	2.33	3.24	3.26
	18	1.68	2.22	2.21	2.78
	19	2.21	2.33	2.12	3.17
	20	2.50	2.26	3.07	2.96
	21	2.21	1.97	2.58	2.96
	22	2.25	2.89	3.02	2.99
	23	1.79	2.04	2.25	3.05
	24	2.14	2.16	2.79	2.85
	25	2.17	1.97	2.31	2.86
	26	2.97	2.07	2.60	2.76
	27	2.51	2.18	1.87	2.56
	28	2.33	2.04	1.92	3.11
Academic Clubs	29	3.08	2.83	2.82	2.25
	30	3.03	3.12	2.74	2.56
	31	3.10	3.24	3.32	2.69
	32	2.48	3.01	3.17	2.71
	33	3.01	3.39	2.95	2.83
	34	2.87	2.54	2.87	3.14
	35	3.04	2.98	2.66	2.98
	36	2.58	2.70	3.53	2.90
	37	3.24	3.17	3.08	3.27
	38	2.77	3.03	3.27	3.13
	39	3.10	3.19	3.39	3.12
	40	2.99	2.99	2.82	3.07
	41	3.10	3.00	2.79	3.19
	42	3.63	3.54	2.96	2.50
	43	2.85	3.05	2.90	3.08

SPSS Instructions

→Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: YEAR
 Number of Levels: 4
 ✓ ADD
 ✓ Define
 Within-Subjects Variables (YEAR):
 FRESHGPA(1)
 SOPHGPA(2)
 JRGPA(3)
 SRGPA(4)
 Between-Subjects Variables:
 CLUB
 ✓Options
 Display Means for: YEAR CLUB YEAR*CLUB
 ✓Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

YEAR	Dependent Variable
1	freshgpa
2	sophgpa
3	jrgpa
4	srgpa

Between-Subjects Factors

	Value Label	N
club	1.00	social clubs 13
	2.00	sports clubs 15
	3.00	academic clubs 15

Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
YEAR	Pillai's Trace	.679	26.855 ^a	3.000	38.000	.000	.679
	Wilks' Lambda	.321	26.855 ^a	3.000	38.000	.000	.679
	Hotelling's Trace	2.120	26.855 ^a	3.000	38.000	.000	.679
	Roy's Largest Root	2.120	26.855 ^a	3.000	38.000	.000	.679
YEAR * club	Pillai's Trace	.673	6.590	6.000	78.000	.000	.336
	Wilks' Lambda	.344	8.938 ^a	6.000	76.000	.000	.414
	Hotelling's Trace	1.861	11.477	6.000	74.000	.000	.482
	Roy's Largest Root	1.835	23.854 ^b	3.000	39.000	.000	.647

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + club

Within Subjects Design: YEAR

Mauchly's Test of Sphericity^b

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 YEAR	.745	11.410	5	.044	.842	.948	.333

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

a. 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.

b. Design: Intercept + club

Within Subjects Design: YEAR

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
YEAR	Sphericity Assumed	7.445	3	2.482	23.855	.000	.374
	Greenhouse-Geisser	7.445	2.525	2.948	23.855	.000	.374
	Huynh-Feldt	7.445	2.844	2.618	23.855	.000	.374
	Lower-bound	7.445	1.000	7.445	23.855	.000	.374
YEAR * club	Sphericity Assumed	5.875	6	.979	9.411	.000	.320
	Greenhouse-Geisser	5.875	5.050	1.163	9.411	.000	.320
	Huynh-Feldt	5.875	5.688	1.033	9.411	.000	.320
	Lower-bound	5.875	2.000	2.937	9.411	.000	.320
Error(YEAR)	Sphericity Assumed	12.485	120	.104			
	Greenhouse-Geisser	12.485	101.007	.124			
	Huynh-Feldt	12.485	113.765	.110			
	Lower-bound	12.485	40.000	.312			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	YEAR	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
YEAR	Linear	6.966	1	6.966	49.392	.000	.553
	Quadratic	.309	1	.309	3.580	.066	.082
	Cubic	.170	1	.170	2.012	.164	.048
YEAR * club	Linear	5.016	2	2.508	17.785	.000	.471
	Quadratic	.765	2	.383	4.428	.018	.181
	Cubic	.093	2	.047	.550	.581	.027
Error(YEAR)	Linear	5.641	40	.141			
	Quadratic	3.456	40	.086			
	Cubic	3.387	40	.085			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1206.676	1	1206.676	8817.349	.000	.995
club	9.805	2	4.902	35.822	.000	.642
Error	5.474	40	.137			

Estimated Marginal Means

1. club

Measure:MEASURE_1

club	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
social clubs	2.478	.051	2.375	2.582
sports clubs	2.497	.048	2.400	2.593
academic clubs	2.989	.048	2.892	3.085

2. YEAR

Measure:MEASURE_1

YEAR	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	2.441	.066	2.308	2.574
2	2.480	.037	2.405	2.554
3	2.745	.058	2.627	2.863
4	2.954	.037	2.878	3.029

3. club * YEAR

Measure:MEASURE_1

club	YEAR	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
social clubs	1	2.089	.119	1.849	2.330
	2	2.198	.067	2.063	2.333
	3	2.632	.106	2.418	2.846
	4	2.994	.068	2.856	3.131
sports clubs	1	2.241	.111	2.017	2.466
	2	2.189	.062	2.063	2.315
	3	2.584	.099	2.385	2.784
	4	2.973	.063	2.845	3.100
academic clubs	1	2.991	.111	2.767	3.216
	2	3.052	.062	2.926	3.177
	3	3.018	.099	2.818	3.217
	4	2.895	.063	2.767	3.023

SPSS Instructions

→Analyze→Compare Means→One-Way ANOVA
 Dependent List: FRESHGPA SOPHGPA JRGPA SRGPA
 Factor: CLUB
 →Options
 √ Descriptives
 √ Welch

 →Post Hoc
 √ Games-Howell
 Significance Level: .0125

Oneway

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
FRESHGPA social clubs	13	2.0895	.65502	.18167	1.6936	2.4853	1.13	3.01
sports clubs	15	2.2415	.29373	.07584	2.0788	2.4042	1.68	2.97
academic clubs	15	2.9912	.27179	.07018	2.8407	3.1417	2.48	3.63
Total	43	2.4571	.57991	.08844	2.2786	2.6355	1.13	3.63
SOPHGPA social clubs	13	2.1982	.23975	.06650	2.0533	2.3431	1.90	2.66
sports clubs	15	2.1890	.23127	.05971	2.0610	2.3171	1.97	2.89
academic clubs	15	3.0518	.25076	.06475	2.9130	3.1907	2.54	3.54
Total	43	2.4928	.47606	.07260	2.3463	2.6393	1.90	3.54
JRGPA social clubs	13	2.6321	.41480	.11504	2.3815	2.8828	1.90	3.24
sports clubs	15	2.5843	.44926	.11600	2.3355	2.8331	1.87	3.24
academic clubs	15	3.0178	.26135	.06748	2.8731	3.1625	2.66	3.53
Total	43	2.7500	.42300	.06451	2.6198	2.8802	1.87	3.53
SRGPA social clubs	13	2.9936	.20435	.05668	2.8701	3.1171	2.64	3.32
sports clubs	15	2.9726	.21733	.05611	2.8522	3.0930	2.56	3.32
academic clubs	15	2.8950	.29762	.07685	2.7302	3.0598	2.25	3.27
Total	43	2.9519	.24300	.03706	2.8771	3.0267	2.25	3.32

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
FRESHGPA	Between Groups	6.734	2	3.367	18.223	.000
	Within Groups	7.391	40	.185		
	Total	14.124	42			
SOPHGPA	Between Groups	7.200	2	3.600	62.098	.000
	Within Groups	2.319	40	.058		
	Total	9.519	42			
JRGPA	Between Groups	1.668	2	.834	5.707	.007
	Within Groups	5.847	40	.146		
	Total	7.515	42			
SRGPA	Between Groups	.078	2	.039	.645	.530
	Within Groups	2.402	40	.060		
	Total	2.480	42			

Robust Tests of Equality of Means

		Statistic ^a	df1	df2	Sig.
FRESHGPA	Welch	29.818	2	23.640	.000
SOPHGPA	Welch	58.322	2	26.345	.000
JRGPA	Welch	7.307	2	24.227	.003
SRGPA	Welch	.537	2	26.339	.591

a. Asymptotically F distributed.

Post Hoc Tests

Multiple Comparisons

Games-Howell

Dependent Variable	(I) CLUB	(J) CLUB	Mean Difference (I-J)	Std. Error	Sig.	98.75% Confidence Interval	
						Lower Bound	Upper Bound
FRESHGPA	social clubs	sports clubs	-.1520	.19686	.725	-.7960	.4920
		academic clubs	-.9018*	.19475	.001	-1.5423	-.2612
	sports clubs	social clubs	.1520	.19686	.725	-.4920	.7960
		academic clubs	-.7497*	.10333	.000	-1.0678	-.4317
	academic clubs	social clubs	.9018*	.19475	.001	.2612	1.5423
		sports clubs	.7497*	.10333	.000	.4317	1.0678
SOPHGPA	social clubs	sports clubs	.0092	.08937	.994	-.2684	.2867
		academic clubs	-.8536*	.09281	.000	-1.1412	-.5660
	sports clubs	social clubs	-.0092	.08937	.994	-.2867	.2684
		academic clubs	-.8628*	.08808	.000	-1.1339	-.5916
	academic clubs	social clubs	.8536*	.09281	.000	.5660	1.1412
		sports clubs	.8628*	.08808	.000	.5916	1.1339
JRGPA	social clubs	sports clubs	.0479	.16337	.954	-.4582	.5539
		academic clubs	-.3857	.13338	.024	-.8106	.0393
	sports clubs	social clubs	-.0479	.16337	.954	-.5539	.4582
		academic clubs	-.4335*	.13420	.010	-.8548	-.0122
	academic clubs	social clubs	.3857	.13338	.024	-.0393	.8106
		sports clubs	.4335*	.13420	.010	.0122	.8548
SRGPA	social clubs	sports clubs	.0210	.07976	.963	-.2261	.2681
		academic clubs	.0985	.09549	.564	-.1984	.3954
	sports clubs	social clubs	-.0210	.07976	.963	-.2681	.2261
		academic clubs	.0776	.09515	.697	-.2174	.3726
	academic clubs	social clubs	-.0985	.09549	.564	-.3954	.1984
		sports clubs	-.0776	.09515	.697	-.3726	.2174

*. The mean difference is significant at the .0125 level.

SPSS Instructions

→Data→Split File
 ✓ Organize Output by Groups
 Groups based on: CLUB
 →Analyze→General Linear Model→Repeated Measures
 Within-Subject Factor Name: YEAR
 Number of Levels: 4
 ✓ ADD
 ✓ Define
 Within-Subjects Variables (YEAR):
 FRESHGPA(1)
 SOPHGPA(2)
 JRGPA(3)
 SRGPA(4)
 ✓Options
 Display Means for: YEAR
 ✓Estimates of Effect Size

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

year	Dependent Variable
1	freshgpa
2	sophgpa
3	jrgpa
4	srgpa

club = social clubs

Between-Subjects Factors^a

--

a. club = social clubs

Multivariate Tests^{b,c}

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
year Pillai's Trace	.889	26.631 ^a	3.000	10.000	.000	.889
Wilks' Lambda	.111	26.631 ^a	3.000	10.000	.000	.889
Hotelling's Trace	7.989	26.631 ^a	3.000	10.000	.000	.889
Roy's Largest Root	7.989	26.631 ^a	3.000	10.000	.000	.889

a. Exact statistic

b. club = social clubs

c. Design: Intercept

Within Subjects Design: year

Mauchly's Test of Sphericity^{b,c}

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 year	.358	11.000	5	.052	.615	.722	.333

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

a. 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.

b. club = social clubs

c. Design: Intercept

Within Subjects Design: year

Tests of Within-Subjects Effects^a

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
year	Sphericity Assumed	6.745	3	2.248	13.972	.000	.538
	Greenhouse-Geisser	6.745	1.846	3.654	13.972	.000	.538
	Huynh-Feldt	6.745	2.166	3.114	13.972	.000	.538
	Lower-bound	6.745	1.000	6.745	13.972	.003	.538
Error(year)	Sphericity Assumed	5.793	36	.161			
	Greenhouse-Geisser	5.793	22.149	.262			
	Huynh-Feldt	5.793	25.992	.223			
	Lower-bound	5.793	12.000	.483			

a. club = social clubs

Tests of Within-Subjects Contrasts^a

Measure: MEASURE_1

Source	year	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
year	Linear	6.434	1	6.434	27.496	.000	.696
	Quadratic	.207	1	.207	1.714	.215	.125
	Cubic	.103	1	.103	.805	.387	.063
Error(year)	Linear	2.808	12	.234			
	Quadratic	1.452	12	.121			
	Cubic	1.532	12	.128			

a. club = social clubs

Tests of Between-Subjects Effects^a

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	319.393	1	319.393	1467.636	.000	.992
Error	2.611	12	.218			

a. club = social clubs

Estimated Marginal Means

year^a

Measure: MEASURE_1

year	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	2.089	.182	1.694	2.485
2	2.198	.066	2.053	2.343
3	2.632	.115	2.381	2.883
4	2.994	.057	2.870	3.117

a. club = social clubs

club = sports clubs

**Between-Subjects
Factors^a**

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a. club = sports clubs

Multivariate Tests^{b,c}

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
year	Pillai's Trace	.894	33.585 ^a	3.000	12.000	.000	.894
	Wilks' Lambda	.106	33.585 ^a	3.000	12.000	.000	.894
	Hotelling's Trace	8.396	33.585 ^a	3.000	12.000	.000	.894
	Roy's Largest Root	8.396	33.585 ^a	3.000	12.000	.000	.894

a. Exact statistic

b. club = sports clubs

c. Design: Intercept

Within Subjects Design: year

Mauchly's Test of Sphericity^{b,c}

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 year	.716	4.250	5	.515	.833	1.000	.333

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

a. 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.

b. club = sports clubs

c. Design: Intercept

Within Subjects Design: year

Tests of Within-Subjects Effects^a

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
year	Sphericity Assumed	5.909	3	1.970	22.921	.000	.621
	Greenhouse-Geisser	5.909	2.498	2.365	22.921	.000	.621
	Huynh-Feldt	5.909	3.000	1.970	22.921	.000	.621
	Lower-bound	5.909	1.000	5.909	22.921	.000	.621
Error(year)	Sphericity Assumed	3.609	42	.086			
	Greenhouse-Geisser	3.609	34.978	.103			
	Huynh-Feldt	3.609	42.000	.086			
	Lower-bound	3.609	14.000	.258			

a. club = sports clubs

Tests of Within-Subjects Contrasts^a

Measure:MEASURE_1

Source	year	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
year	Linear	5.026	1	5.026	61.317	.000	.814
	Quadratic	.729	1	.729	8.766	.010	.385
	Cubic	.155	1	.155	1.671	.217	.107
Error(year)	Linear	1.147	14	.082			
	Quadratic	1.164	14	.083			
	Cubic	1.298	14	.093			

a. club = sports clubs

Tests of Between-Subjects Effects^a

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	374.057	1	374.057	2854.700	.000	.995
Error	1.834	14	.131			

a. club = sports clubs

Estimated Marginal Means

year^a

Measure:MEASURE_1

year	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	2.241	.076	2.079	2.404
2	2.189	.060	2.061	2.317
3	2.584	.116	2.335	2.833
4	2.973	.056	2.852	3.093

a. club = sports clubs

club = academic clubs

Between-Subjects Factors^a

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a. club = academic clubs

Multivariate Tests^{b,c}

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
year Pillai's Trace	.163	.778 ^a	3.000	12.000	.529	.163
Wilks' Lambda	.837	.778 ^a	3.000	12.000	.529	.163
Hotelling's Trace	.194	.778 ^a	3.000	12.000	.529	.163
Roy's Largest Root	.194	.778 ^a	3.000	12.000	.529	.163

a. Exact statistic

b. club = academic clubs

c. Design: Intercept

Within Subjects Design: year

Mauchly's Test of Sphericity^{b,c}

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
dimension1 year	.466	9.710	5	.085	.732	.874	.333

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

a. 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.

b. club = academic clubs

c. Design: Intercept

Within Subjects Design: year

Tests of Within-Subjects Effects^a

Measure: MEASURE_1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
year Sphericity Assumed	.204	3	.068	.927	.436	.062
Greenhouse-Geisser	.204	2.196	.093	.927	.414	.062
Huynh-Feldt	.204	2.621	.078	.927	.427	.062
Lower-bound	.204	1.000	.204	.927	.352	.062
Error(year) Sphericity Assumed	3.083	42	.073			
Greenhouse-Geisser	3.083	30.739	.100			
Huynh-Feldt	3.083	36.689	.084			
Lower-bound	3.083	14.000	.220			

a. club = academic clubs

Tests of Within-Subjects Contrasts^a

Measure:MEASURE_1

Source	year	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
year	Linear	.078	1	.078	.649	.434	.044
	Quadratic	.126	1	.126	2.101	.169	.130
	Cubic	2.590E-5	1	2.590E-5	.001	.980	.000
Error(year)	Linear	1.686	14	.120			
	Quadratic	.840	14	.060			
	Cubic	.557	14	.040			

a. club = academic clubs

Tests of Between-Subjects Effects^a

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	536.035	1	536.035	7298.916	.000	.998
Error	1.028	14	.073			

a. club = academic clubs

Estimated Marginal Means

year^a

Measure:MEASURE_1

year	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	2.991	.070	2.841	3.142
2	3.052	.065	2.913	3.191
3	3.018	.067	2.873	3.163
4	2.895	.077	2.730	3.060

a. club = academic clubs

SPSS Instructions

→ Analyze → Compare Means → Paired Samples T Test

Paired Variables:

Pair 1: FRESHGPA SOPHGPA

Pair 2: FRESHGPA JRGPA

Pair 3: FRESHGPA SRGPA

Pair 4: SOPHGPA JRGPA

Pair 5: SOPHGPA SRGPA

Pair 6: JRGPA SRGPA

T-Test

CLUB = social clubs

Paired Samples Statistics^a

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FRESHGPA	2.0895	13	.65502	.18167
	SOPHGPA	2.1982	13	.23975	.06650
Pair 2	FRESHGPA	2.0895	13	.65502	.18167
	JRGPA	2.6321	13	.41480	.11504
Pair 3	FRESHGPA	2.0895	13	.65502	.18167
	SRGPA	2.9936	13	.20435	.05668
Pair 4	SOPHGPA	2.1982	13	.23975	.06650
	JRGPA	2.6321	13	.41480	.11504
Pair 5	SOPHGPA	2.1982	13	.23975	.06650
	SRGPA	2.9936	13	.20435	.05668
Pair 6	JRGPA	2.6321	13	.41480	.11504
	SRGPA	2.9936	13	.20435	.05668

a. CLUB = social clubs

Paired Samples Correlations^a

		N	Correlation	Sig.
Pair 1	FRESHGPA & SOPHGPA	13	.016	.958
Pair 2	FRESHGPA & JRGPA	13	.320	.286
Pair 3	FRESHGPA & SRGPA	13	-.325	.279
Pair 4	SOPHGPA & JRGPA	13	.321	.285
Pair 5	SOPHGPA & SRGPA	13	.069	.824
Pair 6	JRGPA & SRGPA	13	.043	.888

a. CLUB = social clubs

Paired Samples Test^a

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 FRESHGPA - SOPHGPA	-.1087	.69384	.19244	-.5280	.3105	-.565	12	.582
Pair 2 FRESHGPA - JRGPA	-.5427	.65354	.18126	-.9376	-.1478	-2.994	12	.011
Pair 3 FRESHGPA - SRGPA	-.9041	.74679	.20712	-1.3554	-.4528	-4.365	12	.001
Pair 4 SOPHGPA - JRGPA	-.4339	.40704	.11289	-.6799	-.1880	-3.844	12	.002
Pair 5 SOPHGPA - SRGPA	-.7954	.30418	.08436	-.9792	-.6116	-9.428	12	.000
Pair 6 JRGPA - SRGPA	-.3614	.45438	.12602	-.6360	-.0868	-2.868	12	.014

a. CLUB = social clubs

CLUB = sports clubs

Paired Samples Statistics^a

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 FRESHGPA	2.2415	15	.29373	.07584
1 SOPHGPA	2.1890	15	.23127	.05971
Pair 2 FRESHGPA	2.2415	15	.29373	.07584
2 JRGPA	2.5843	15	.44926	.11600
Pair 3 FRESHGPA	2.2415	15	.29373	.07584
3 SRGPA	2.9726	15	.21733	.05611
Pair 4 SOPHGPA	2.1890	15	.23127	.05971
4 JRGPA	2.5843	15	.44926	.11600
Pair 5 SOPHGPA	2.1890	15	.23127	.05971
5 SRGPA	2.9726	15	.21733	.05611
Pair 6 JRGPA	2.5843	15	.44926	.11600
6 SRGPA	2.9726	15	.21733	.05611

a. CLUB = sports clubs

Paired Samples Correlations^a

	N	Correlation	Sig.
Pair 1 FRESHGPA & SOPHGPA	15	-.004	.989
Pair 2 FRESHGPA & JRGPA	15	.104	.713
Pair 3 FRESHGPA & SRGPA	15	-.194	.489
Pair 4 SOPHGPA & JRGPA	15	.309	.263
Pair 5 SOPHGPA & SRGPA	15	.165	.558
Pair 6 JRGPA & SRGPA	15	.269	.333

a. CLUB = sports clubs

Paired Samples Test^a

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 FRESHGPA - SOPHGPA	.0524	.37457	.09671	-.1550	.2599	.542	14	.596
Pair 2 FRESHGPA - JRGPA	-.3428	.51060	.13184	-.6256	-.0600	-2.600	14	.021
Pair 3 FRESHGPA - SRGPA	-.7311	.39780	.10271	-.9514	-.5108	-7.118	14	.000
Pair 4 SOPHGPA - JRGPA	-.3952	.43719	.11288	-.6373	-.1531	-3.501	14	.004
Pair 5 SOPHGPA - SRGPA	-.7836	.29012	.07491	-.9442	-.6229	-10.460	14	.000
Pair 6 JRGPA - SRGPA	-.3883	.44343	.11449	-.6339	-.1428	-3.392	14	.004

a. CLUB = sports clubs

CLUB = academic clubs

Paired Samples Statistics^a

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FRESHGPA	2.9912	15	.27179	.07018
	SOPHGPA	3.0518	15	.25076	.06475
Pair 2	FRESHGPA	2.9912	15	.27179	.07018
	JRGPA	3.0178	15	.26135	.06748
Pair 3	FRESHGPA	2.9912	15	.27179	.07018
	SRGPA	2.8950	15	.29762	.07685
Pair 4	SOPHGPA	3.0518	15	.25076	.06475
	JRGPA	3.0178	15	.26135	.06748
Pair 5	SOPHGPA	3.0518	15	.25076	.06475
	SRGPA	2.8950	15	.29762	.07685
Pair 6	JRGPA	3.0178	15	.26135	.06748
	SRGPA	2.8950	15	.29762	.07685

a. CLUB = academic clubs

Paired Samples Correlations^a

		N	Correlation	Sig.
Pair 1	FRESHGPA & SOPHGPA	15	.624	.013
Pair 2	FRESHGPA & JRGPA	15	-.340	.215
Pair 3	FRESHGPA & SRGPA	15	-.182	.517
Pair 4	SOPHGPA & JRGPA	15	.021	.942
Pair 5	SOPHGPA & SRGPA	15	-.204	.467
Pair 6	JRGPA & SRGPA	15	.131	.641

a. CLUB = academic clubs

Paired Samples Test^a

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FRESHGPA - SOPHGPA	-.0606	.22729	.05869	-.1865	.0653	-1.033	14	.319
Pair 2	FRESHGPA - JRGPA	-.0266	.43642	.11268	-.2682	.2151	-.236	14	.817
Pair 3	FRESHGPA - SRGPA	.0962	.43802	.11310	-.1464	.3388	.851	14	.409
Pair 4	SOPHGPA - JRGPA	.0340	.35846	.09255	-.1645	.2325	.368	14	.719
Pair 5	SOPHGPA - SRGPA	.1568	.42645	.11011	-.0794	.3930	1.424	14	.176
Pair 6	JRGPA - SRGPA	.1228	.36937	.09537	-.0818	.3273	1.287	14	.219

a. CLUB = academic clubs

SPSS Instructions
 →Data→Split File
 √ Analyze all cases; do not create groups