

# Statistical Analysis in the third study for signed-up students

Table 1: Two-way ANOVA and Scheirer-Ray-Hare in the third study for signed-up students

	Sum Sq	Df	F value	Pr(>F)	Sig	Df	Sum Sq	H	p.value	Sig
Interest/Enjoyment.(Intercept)	593.543	1	544.496	0.000						
Interest/Enjoyment.Type	1.948	1	1.787	0.188		1	116.659	0.531	0.466	
Interest/Enjoyment.CLRole	1.420	1	1.303	0.259		1	398.500	1.813	0.178	
Interest/Enjoyment.Type:CLRole	2.608	1	2.392	0.129		1	413.063	1.879	0.170	
Interest/Enjoyment.Residuals	51.234	47				47	10060.778			
Perceived Choice.(Intercept)	795.351	1	405.731	0.000						
Perceived Choice.Type	16.215	1	8.272	0.006	**	1	1229.745	5.587	0.018	*
Perceived Choice.CLRole	0.807	1	0.412	0.524		1	58.513	0.266	0.606	
Perceived Choice.Type:CLRole	2.604	1	1.328	0.255		1	274.660	1.248	0.264	
Perceived Choice.Residuals	92.134	47				47	9442.582			
Pressure/Tension.(Intercept)	417.559	1	279.123	0.000						
Pressure/Tension.Type	0.152	1	0.102	0.751		1	0.492	0.002	0.962	
Pressure/Tension.CLRole	22.933	1	15.330	0.000	**	1	1711.859	7.804	0.005	**
Pressure/Tension.Type:CLRole	0.000	1	0.000	0.996		1	40.610	0.185	0.667	
Pressure/Tension.Residuals	70.310	47				47	9215.539			
Effort/Importance.(Intercept)	1059.967	1	781.266	0.000						
Effort/Importance.Type	10.200	1	7.518	0.009	**	1	1289.481	5.893	0.015	*
Effort/Importance.CLRole	1.362	1	1.004	0.322		1	149.901	0.685	0.408	
Effort/Importance.Type:CLRole	0.004	1	0.003	0.960		1	2.171	0.010	0.921	
Effort/Importance.Residuals	63.766	47				47	9498.447			
Intrinsic Motivation.(Intercept)	865.068	1	1735.886	0.000						
Intrinsic Motivation.Type	3.065	1	6.150	0.017	*	1	926.520	4.193	0.041	*
Intrinsic Motivation.CLRole	1.506	1	3.022	0.089		1	479.489	2.170	0.141	
Intrinsic Motivation.Type:CLRole	0.755	1	1.516	0.224		1	251.422	1.138	0.286	
Intrinsic Motivation.Residuals	23.422	47				47	9391.570			
Attention.(Intercept)	654.206	1	376.621	0.000						
Attention.Type	0.072	1	0.041	0.840		1	33.973	0.148	0.700	
Attention.CLRole	0.514	1	0.296	0.589		1	22.023	0.096	0.756	
Attention.Type:CLRole	0.317	1	0.183	0.671		1	46.860	0.205	0.651	
Attention.Residuals	81.641	47				48	11577.143			
Relevance.(Intercept)	1027.186	1	1020.632	0.000						
Relevance.Type	3.909	1	3.884	0.055		1	310.633	1.365	0.243	
Relevance.CLRole	3.249	1	3.228	0.079		1	467.303	2.053	0.152	
Relevance.Type:CLRole	2.167	1	2.154	0.149		1	280.216	1.231	0.267	
Relevance.Residuals	47.302	47				48	10548.849			
Satisfaction.(Intercept)	808.461	1	345.615	0.000						
Satisfaction.Type	3.302	1	1.412	0.241		1	268.166	1.173	0.279	
Satisfaction.CLRole	1.277	1	0.546	0.464		1	88.555	0.387	0.534	
Satisfaction.Type:CLRole	0.294	1	0.126	0.724		1	26.457	0.116	0.734	
Satisfaction.Residuals	109.942	47				48	11271.822			

Table 1: *(continued)*

	Sum Sq	Df	F value	Pr(>F)	Sig	Df	Sum Sq	H	p.value	Sig
Level of Motivation.(Intercept)	800.449	1	998.943	0.000						
Level of Motivation.Type	0.325	1	0.406	0.527		1	83.893	0.366	0.545	
Level of Motivation.CLRole	0.368	1	0.460	0.501		1	97.932	0.427	0.513	
Level of Motivation.Type:CLRole	0.273	1	0.341	0.562		1	116.729	0.509	0.476	
Level of Motivation.Residuals	37.661	47				48	11397.445			

Signif. codes: 0 '\*\*\*' 0.01 '\*\*' 0.05

Table 2: Summary of Tukey post-hoc in the third study for signed-up students

	N	mean	lsmean	SE	df	lwr.CI	upr.CI	t.ratio	p.value	p.adj	g	sig	mag
Perceived Choice:ont-gamified - w/o-gamified	51	1.063	1.200	0.417		0.273	1.853	2.876	0.006	0.009	0.750	**	medium
Effort/Importance:ont-gamified - w/o-gamified	51	0.930	0.952	0.347		0.273	1.588	2.742	0.009	0.007	0.795	**	medium
Intrinsic Motivation:ont-gamified - w/o-gamified	51	0.465	0.522	0.210		0.067	0.864	2.480	0.017	0.023	0.633	*	medium

Table 3: Summary of Pair wilcoxon in the third study for signed-up students

	Group	N	Median	Mean.Ranks	Sum.Ranks	U	Z	p.value	r	magnitude
Interest/Enjoyment.Type:CLRole.less.1	ont-gamified.Apprentice	15	3.83	10.53	158.0	38.0	-1.78	0.039	0.362	medium
Interest/Enjoyment.Type:CLRole.less.2	ont-gamified.Master	9	4.00	15.78	142.0	38.0	-1.78	0.039	0.362	medium
Interest/Enjoyment.Type:CLRole.greater.1	ont-gamified.Master	9	4.00	18.44	166.0	121.0	1.75	0.041	0.331	medium
Interest/Enjoyment.Type:CLRole.greater.2	w/o-gamified.Apprentice	19	3.67	12.63	240.0	121.0	1.75	0.041	0.331	medium
Perceived Choice.Type.greater.1	ont-gamified	24	4.80	31.21	749.0	449.0	2.36	0.009	0.331	medium
Perceived Choice.Type.greater.2	w/o-gamified	27	3.80	21.37	577.0	449.0	2.36	0.009	0.331	medium
Perceived Choice.Type.two.sided.1	ont-gamified	24	4.80	31.21	749.0	449.0	2.36	0.017	0.331	medium
Perceived Choice.Type.two.sided.2	w/o-gamified	27	3.80	21.37	577.0	449.0	2.36	0.017	0.331	medium
Perceived Choice.Type:CLRole.greater.1	ont-gamified.Master	9	5.40	19.56	176.0	131.0	2.25	0.012	0.424	medium
Perceived Choice.Type:CLRole.greater.2	w/o-gamified.Apprentice	19	4.00	12.11	230.0	131.0	2.25	0.012	0.424	medium
Perceived Choice.Type:CLRole.two.sided.1	ont-gamified.Master	9	5.40	19.56	176.0	131.0	2.25	0.023	0.424	medium
Perceived Choice.Type:CLRole.two.sided.2	w/o-gamified.Apprentice	19	4.00	12.11	230.0	131.0	2.25	0.023	0.424	medium
Perceived Choice.Type:CLRole.greater.11	ont-gamified.Master	9	5.40	11.50	103.5	58.5	2.17	0.015	0.526	large
Perceived Choice.Type:CLRole.greater.21	w/o-gamified.Master	8	3.20	6.19	49.5	58.5	2.17	0.015	0.526	large
Perceived Choice.Type:CLRole.two.sided.11	ont-gamified.Master	9	5.40	11.50	103.5	58.5	2.17	0.029	0.526	large
Perceived Choice.Type:CLRole.two.sided.21	w/o-gamified.Master	8	3.20	6.19	49.5	58.5	2.17	0.029	0.526	large
Pressure/Tension.Type:CLRole.greater.1	ont-gamified.Apprentice	15	4.00	15.10	226.5	106.5	2.33	0.009	0.476	medium
Pressure/Tension.Type:CLRole.greater.2	ont-gamified.Master	9	2.25	8.17	73.5	106.5	2.33	0.009	0.476	medium
Pressure/Tension.Type:CLRole.two.sided.1	ont-gamified.Apprentice	15	4.00	15.10	226.5	106.5	2.33	0.018	0.476	medium
Pressure/Tension.Type:CLRole.two.sided.2	ont-gamified.Master	9	2.25	8.17	73.5	106.5	2.33	0.018	0.476	medium
Pressure/Tension.Type:CLRole.greater.11	ont-gamified.Apprentice	15	4.00	13.87	208.0	88.0	1.81	0.036	0.378	medium
Pressure/Tension.Type:CLRole.greater.21	w/o-gamified.Master	8	1.75	8.50	68.0	88.0	1.81	0.036	0.378	medium
Pressure/Tension.Type:CLRole.less.1	ont-gamified.Master	9	2.25	9.83	88.5	43.5	-2.08	0.019	0.392	medium
Pressure/Tension.Type:CLRole.less.2	w/o-gamified.Apprentice	19	3.75	16.71	317.5	43.5	-2.08	0.019	0.392	medium
Pressure/Tension.Type:CLRole.two.sided.11	ont-gamified.Master	9	2.25	9.83	88.5	43.5	-2.08	0.037	0.392	medium
Pressure/Tension.Type:CLRole.two.sided.21	w/o-gamified.Apprentice	19	3.75	16.71	317.5	43.5	-2.08	0.037	0.392	medium
Effort/Importance.Type.greater.1	ont-gamified	24	5.50	31.33	752.0	452.0	2.43	0.007	0.340	medium
Effort/Importance.Type.greater.2	w/o-gamified	27	4.33	21.26	574.0	452.0	2.43	0.007	0.340	medium
Effort/Importance.Type.two.sided.1	ont-gamified	24	5.50	31.33	752.0	452.0	2.43	0.014	0.340	medium
Effort/Importance.Type.two.sided.2	w/o-gamified	27	4.33	21.26	574.0	452.0	2.43	0.014	0.340	medium
Effort/Importance.Type:CLRole.greater.1	ont-gamified.Apprentice	15	5.67	21.47	322.0	202.0	2.08	0.019	0.356	medium
Effort/Importance.Type:CLRole.greater.2	w/o-gamified.Apprentice	19	4.33	14.37	273.0	202.0	2.08	0.019	0.356	medium
Effort/Importance.Type:CLRole.two.sided.1	ont-gamified.Apprentice	15	5.67	21.47	322.0	202.0	2.08	0.037	0.356	medium
Effort/Importance.Type:CLRole.two.sided.2	w/o-gamified.Apprentice	19	4.33	14.37	273.0	202.0	2.08	0.037	0.356	medium
Effort/Importance.Type:CLRole.greater.11	ont-gamified.Apprentice	15	5.67	14.07	211.0	91.0	2.01	0.022	0.420	medium
Effort/Importance.Type:CLRole.greater.21	w/o-gamified.Master	8	4.17	8.12	65.0	91.0	2.01	0.022	0.420	medium
Effort/Importance.Type:CLRole.two.sided.11	ont-gamified.Apprentice	15	5.67	14.07	211.0	91.0	2.01	0.044	0.420	medium
Effort/Importance.Type:CLRole.two.sided.21	w/o-gamified.Master	8	4.17	8.12	65.0	91.0	2.01	0.044	0.420	medium

Table 3: *(continued)*

	Group	N	Median	Mean.Ranks	Sum.Ranks	U	Z	p.value	r	magnitude
Intrinsic Motivation.Type.greater.1	ont-gamified	24	4.57	30.52	732.5	432.5	2.05	0.020	0.287	small
Intrinsic Motivation.Type.greater.2	w/o-gamified	27	4.08	21.98	593.5	432.5	2.05	0.020	0.287	small

Table 3: (continued)

	Group	N	Median	Mean.Ranks	Sum.Ranks	U	Z	p.value	r	magnitude
Intrinsic Motivation.Type.two.sided.1	ont-gamified	24	4.57	30.52	732.5	432.5	2.05	0.040	0.287	small
Intrinsic Motivation.Type.two.sided.2	w/o-gamified	27	4.08	21.98	593.5	432.5	2.05	0.040	0.287	small
Intrinsic Motivation.Type:CLRole.less.1	ont-gamified.Apprentice	15	4.31	10.20	153.0	33.0	-2.06	0.020	0.420	medium
Intrinsic Motivation.Type:CLRole.less.2	ont-gamified.Master	9	5.01	16.33	147.0	33.0	-2.06	0.020	0.420	medium
Intrinsic Motivation.Type:CLRole.two.sided.1	ont-gamified.Apprentice	15	4.31	10.20	153.0	33.0	-2.06	0.039	0.420	medium
Intrinsic Motivation.Type:CLRole.two.sided.2	ont-gamified.Master	9	5.01	16.33	147.0	33.0	-2.06	0.039	0.420	medium
Intrinsic Motivation.Type:CLRole.greater.1	ont-gamified.Master	9	5.01	20.00	180.0	135.0	2.43	0.007	0.460	medium
Intrinsic Motivation.Type:CLRole.greater.2	w/o-gamified.Apprentice	19	3.94	11.89	226.0	135.0	2.43	0.007	0.460	medium
Intrinsic Motivation.Type:CLRole.two.sided.11	ont-gamified.Master	9	5.01	20.00	180.0	135.0	2.43	0.014	0.460	medium
Intrinsic Motivation.Type:CLRole.two.sided.21	w/o-gamified.Apprentice	19	3.94	11.89	226.0	135.0	2.43	0.014	0.460	medium
Intrinsic Motivation.Type:CLRole.greater.11	ont-gamified.Master	9	5.01	11.22	101.0	56.0	1.92	0.030	0.467	medium
Intrinsic Motivation.Type:CLRole.greater.21	w/o-gamified.Master	8	4.25	6.50	52.0	56.0	1.92	0.030	0.467	medium
Relevance.Type:CLRole.less.1	ont-gamified.Apprentice	16	4.50	11.03	176.5	40.5	-1.79	0.038	0.358	medium
Relevance.Type:CLRole.less.2	ont-gamified.Master	9	6.00	16.50	148.5	40.5	-1.79	0.038	0.358	medium
Relevance.Type:CLRole.greater.1	ont-gamified.Master	9	6.00	18.83	169.5	124.5	1.93	0.027	0.364	medium
Relevance.Type:CLRole.greater.2	w/o-gamified.Apprentice	19	4.50	12.45	236.5	124.5	1.93	0.027	0.364	medium
Relevance.Type:CLRole.greater.11	ont-gamified.Master	9	6.00	10.94	98.5	53.5	1.69	0.048	0.411	medium
Relevance.Type:CLRole.greater.21	w/o-gamified.Master	8	4.50	6.81	54.5	53.5	1.69	0.048	0.411	medium

# 1 Assumptions for Parametric Tests

Table 4: Univariate normality test in the third study for signed-up students

	normality.fail	W	p.value
Interest/Enjoyment	FALSE	0.959	0.074
Perceived Choice	FALSE	0.978	0.451
Pressure/Tension	FALSE	0.964	0.128
Effort/Importance	FALSE	0.962	0.098
Intrinsic Motivation	FALSE	0.977	0.423
Attention	FALSE	0.973	0.304
Relevance	FALSE	0.982	0.647
Satisfaction	FALSE	0.956	0.055
Level of Motivation	FALSE	0.970	0.220

Table 5: Notes to be taken into account about sample size in the third study for signed-up students

	code	description
Interest/Enjoyment.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Interest/Enjoyment.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Perceived Choice.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Perceived Choice.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Pressure/Tension.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Pressure/Tension.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Effort/Importance.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Effort/Importance.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Intrinsic Motivation.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Intrinsic Motivation.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Attention.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Attention.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Relevance.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Relevance.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Satisfaction.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Satisfaction.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.
Level of Motivation.Type.1	WARN: sample.size	current size is 9 and recommended size is 15 for the group: 'ont-gamified:Master'.
Level of Motivation.Type.2	WARN: sample.size	current size is 8 and recommended size is 15 for the group: 'w/o-gamified:Master'.

Recent studies carried out through simulations have indicated that ANOVA is reliable even when the data are non-normally distributed and the sample size is greater than 15 observations for each group. This size value is based on the Reference: Rana, R. K., Singhal, R., & Dua, P. (2016). Deciphering the dilemma of parametric and nonparametric tests. Journal of the Practice of Cardiovascular Sciences, 2(2), 95.

The sample size to be carried out any parametric and non-parametric analysis is 5, and it was established using common sense. The warning and fails indicated in this section should be taken into account when a paper or report will be elaborated.