

Supplementary Table S1. Item-Level Descriptive Statistics, Standardized Factor Loadings, Residual Variances, Explained Variance, and Latent Factor Correlations

<i>Construct</i>	<i>Item</i>	Mean	SD	Skewness	Kurtosis	λ	θ	R^2
Designing Fun	PSD1	2.57	1.12	0.56	-0.41	0.624	0.611	0.389
Designing Fun	PSD3	1.82	0.99	1.26	1.21	0.714	0.490	0.510
Designing Fun	PSD5	2.38	1.14	0.54	-0.59	0.742	0.449	0.551
Designing Fun	PSD7	2.39	1.15	0.55	-0.49	0.758	0.426	0.574
Designing Fun	PSD9	2.35	1.15	0.54	-0.63	0.869	0.244	0.756
Designing Fun	PSD11	2.76	1.27	0.21	-1.00	0.585	0.658	0.342
Designing Competition	PSD2	3.79	1.02	-0.55	-0.42	0.266	0.929	0.071
Designing Competition	PSD4	3.57	1.02	-0.38	-0.39	0.343	0.882	0.118
Designing Competition	PSD6	2.37	1.22	0.49	-0.83	0.652	0.575	0.425
Designing Competition	PSD8	2.59	1.20	0.37	-0.77	0.831	0.310	0.690
Designing Competition	PSD10	2.86	1.18	0.20	-0.88	0.479	0.770	0.230
Designing Competition	PSD12	2.42	1.16	0.42	-0.77	0.781	0.390	0.610
Factors Correlation Designing Fun and Designing Competition $r = 0.716$								
Vigor	UES_S1	3.85	1.41	0.03	-0.45	0.840	0.294	0.706
Vigor	UES_S2	3.12	1.49	0.50	-0.35	0.629	0.604	0.396
Vigor	UES_S3	3.30	1.27	0.13	0.00	0.897	0.195	0.805
Vigor	UES_S4	3.33	1.40	0.31	-0.22	0.878	0.230	0.770
Vigor	UES_S5	3.40	1.58	0.22	-0.64	0.477	0.773	0.227
Vigor	UES_S6	4.25	1.60	0.05	-0.78	0.549	0.698	0.302
Dedication	UES_S7	5.26	1.46	-0.54	-0.48	0.863	0.255	0.745
Dedication	UES_S8	5.55	1.42	-0.81	-0.03	0.928	0.139	0.861
Dedication	UES_S9	5.64	1.34	-0.70	-0.48	0.936	0.124	0.876
Dedication	UES_S10	5.63	1.35	-0.75	-0.32	0.907	0.177	0.823
Dedication	UES_S11	5.62	1.36	-0.76	-0.28	0.913	0.166	0.834
Absorption	UES_S12	3.98	1.66	0.03	-0.72	0.657	0.568	0.432
Absorption	UES_S13	3.58	1.63	0.32	-0.62	0.685	0.530	0.470
Absorption	UES_S14	4.82	1.76	-0.32	-0.94	0.609	0.630	0.370
Absorption	UES_S15	4.74	1.49	-0.32	-0.64	0.674	0.545	0.455
Absorption	UES_S16	3.39	1.54	0.24	-0.60	0.759	0.423	0.577
Absorption	UES_S17	3.93	1.52	0.06	-0.61	0.789	0.378	0.622

Factors Correlation Vigor and Dedication $r = 0.465$ Factors Correlation Vigor and Absorption $r = 0.683$ Factors Correlation Dedication and Absorption $r = 0.659$

Emotional Well-Being	MHC1	3.17	1.10	-0.68	0.16	0.757	0.427	0.573
Emotional Well-Being	MHC2	3.50	1.24	-0.84	0.28	0.804	0.354	0.646
Emotional Well-Being	MHC3	2.87	1.25	-0.42	-0.33	0.760	0.423	0.577
Social Well-Being	MHC4	2.26	1.45	0.13	-0.88	0.534	0.715	0.285
Social Well-Being	MHC5	3.07	1.53	-0.53	-0.76	0.492	0.758	0.242
Social Well-Being	MHC6	1.45	1.41	0.64	-0.65	0.798	0.363	0.637
Social Well-Being	MHC7	1.88	1.36	0.33	-0.80	0.727	0.472	0.528
Social Well-Being	MHC8	1.47	1.26	0.71	-0.17	0.770	0.408	0.592
Psychological Well-Being	MHC9	2.73	1.36	-0.21	-0.82	0.694	0.518	0.482
Psychological Well-Being	MHC10	2.96	1.35	-0.38	-0.65	0.731	0.465	0.535
Psychological Well-Being	MHC11	3.42	1.27	-0.69	-0.17	0.622	0.614	0.386
Psychological Well-Being	MHC12	3.72	1.30	-0.96	0.14	0.624	0.611	0.389
Psychological Well-Being	MHC13	3.52	1.24	-0.70	-0.20	0.660	0.565	0.435
Psychological Well-Being	MHC14	3.32	1.42	-0.56	-0.65	0.774	0.401	0.599

Factors Correlation Emotional and Social Well-Being $r = 0.604$

Factors Correlation Emotional and Psychological Well-Being $r = 0.890$

Factors Correlation Social and Psychological Well-Being $r = 0.630$

Note. λ = Standardized factor loading; θ = Residual variance; R^2 = the proportion of item variance explained by its factor; all λ were statistically significant at $p < .001$. No correlated residuals among individual items were specified. Despite the high latent correlation between emotional and psychological well-being ($r = .890$), the three-factor well-being model fitted the data significantly better than the alternative model combining these two dimensions, $\Delta\chi^2(2) = 42.87$, $p < .001$.

Supplementary Table S2. Sensitivity and Dimension-Specific Structural Analyses

Associations	Student engagement β [CI]	Emotional well-being β [CI]	Social well-being β [CI]	Psychological well-being β [CI]
Total, direct, and indirect associations estimated using WLSMV				
Total Associations				
Playful Study Design	0.27 [0.16; 0.37]	0.12 [0.05; 0.20]	0.16 [0.07; 0.24]	0.12 [0.05; 0.20]
Direct Associations				
Playful Study Design		-0.01 [-0.05; 0.04]	0.08 [0.01; 0.14]	-0.02 [-0.07; 0.04]
Student Engagement		0.48 [0.39; 0.58]	0.29 [0.20; 0.41]	0.52 [0.44; 0.61]
Indirect Associations				
Playful Study Design		0.13 [0.08; 0.18]	0.08 [0.04; 0.13]	0.14 [0.08; 0.20]
Total, direct, and indirect associations estimated with Designing Fun and Designing Competition as distinct predictors				
Total Associations				
Designing Fun	-0.31 [-0.48; -0.15]	-0.08 [-0.25; 0.08]	0.12 [-0.05; 0.27]	-0.10 [-0.28; 0.06]
Designing Competition	0.77 [0.60; 0.94]	0.28 [0.12; 0.44]	0.18 [0.03; 0.34]	
Direct Associations				
Designing Fun		0.07 [-0.10; 0.24]	0.19 [0.02; 0.35]	0.06 [-0.10; 0.23]
Designing Competition		-0.10 [-0.32; 0.11]	0.00 [-0.22; 0.22]	-0.09 [-0.33; 0.12]
Student Engagement		0.49 [0.34; 0.64]	0.24 [0.07; 0.40]	0.52 [0.38; 0.68]
Indirect Associations				
Designing Fun		-0.15 [-0.27; -0.07]	-0.07 [-0.16; -0.02]	-0.16 [-0.29; -0.07]
Designing Competition		0.37 [0.24; 0.55]	0.18 [0.06; 0.34]	

Note. β = completely standardized coefficient (STDYX standardization); CI = 95% confidence interval; WLSMV = weighted least squares mean- and variance-adjusted estimator.