Data Analysis of a Large-scale Evaluation of a Model for the Evaluation of Games for Teaching Software Engineering

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This working paper details the data analysis from a statistical evaluation of a model for the evaluation of games for teaching software engineering (MEEGA).

The objective of the study is analyze the MEEGA questionnaire in order to evaluate its quality in terms of reliability and construct validity from the viewpoint of the researchers in the context of higher SE education and professional training.

Following this objective, we present the statistical results for each analysis questions:

Reliability

AQ1: Is there evidence for internal consistency of the MEEGA questionnaire?

Table 1. Cronbach's alpha per quality factor

Quality factor	Cronbach's alpha
Motivation	.802
User Experience	.862
Learning	.797
Total	**.915**

Table 2. Cronbach's alpha for customized items

Quality factor	Cronbach's alpha
Learning objectives	.966

Construct Validity

AQ2: Is there evidence of convergent and discriminant validity of the MEEGA questionnaire?

Table 3. Spearman correlation coefficient of quality factor: Motivation

No.	1	2	3	4	5	6	7	8	9	10
Item	Attention			Relevance			Confidence		Satisfaction	
1	1.00									
2	**.367**	1.00								
3	**.339**	**.458**	1.00							
4	.247	.289	**.372**	1.00						
5	.269	.274	**.380**	**.404**	1.00					
6	.140	.240	.254	.272	**.304**	1.00				
7	.212	.172	.152	.209	.230	.230	1.00			
8	.203	**.298**	**.397**	**.322**	**.472**	.251	.268	1.00		
9	.231	**.335**	**.431**	**.426**	**.392**	.275	.198	**.472**	1.00	
10	.152	.255	.276	.233	.246	.272	.192	.267	**.374**	1.00

Table 4. Spearman correlation coefficient of quality factor: User Experience

No. Item/ Dimension	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Immersion			Social Interaction			Challenge		Fun				Competence		Digital Game	
11	1.000															
12	**.625**	1.000														
13	**.598**	**.637**	1.000													
14	.264	.239	.253	1.000												
15	**.398**	**.393**	**.364**	**.641**	1.000											
16	**.332**	**.354**	**.319**	**.556**	**.586**	1.000										
17	.287	**.291**	.260	.238	.279	**.303**	1.000									
18	**.377**	**.411**	**.420**	.287	**.396**	**.331**	**.455**	1.000								
19	**.412**	**.471**	**.416**	**.316**	**.548**	**.421**	**.359**	**.565**	1.000							
20	**.303**	**.400**	**.400**	.113	.265	.170	.265	**.335**	**.387**	1.000						
21	**.360**	**.382**	**.396**	.203	**.324**	.274	**.404**	**.482**	**.530**	**.454**	1.000					
22	**.302**	**.396**	**.372**	.157	.276	.236	**.349**	**.418**	**.461**	**.489**	**.680**	1.000				
23	**.301**	**.310**	**.352**	.142	.168	.210	**.292**	**.363**	**.332**	.279	**.369**	**.343**	1.000			
24	**.370**	**.376**	**.401**	.168	**.307**	.283	**.401**	**.445**	**.465**	**.374**	**.466**	**.457**	**.496**	1.000		
25	-142	-.101	-.113	-.220	-.128	-.118	-.173	-.208	-.078	.053	-.079	-.037	-.011	-.060	1.000	
26	-.148	-.104	-.128	-.200	-.119	-.086	-.153	-.210	-.054	.037	-.086	-.042	-.023	-.097	**.784**	1.000

Table 5. Spearman correlation coefficient of quality factor: Learning

	27	28	29
	Short-term Learning		Long-term Learning
27	1.000		
28	**.620**	1.000	
29	**.528**	**.460**	1.000

Table 6. Nonparametric Spearman correlation matrix for all quality factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	Motivation										User Experience																Learning		
	Attention			Relevance			Confidence		Satisfaction		Immersion			Social Interaction			Challenge		Fun				Competence		Digital Game		Short-term		Long -term
1	1																												
2	**.367**	1																											
3	**.339**	**.458**	1																										
4	.247	.289	**.372**	1																									
5	.269	.274	**.380**	**.404**	1																								
6	.140	.240	.254	.272	**.304**	1																							
7	.212	.172	.152	.209	.230	.230	1																						
8	.203	**.298**	**.397**	**.322**	**.472**	.251	.268	1																					
9	.231	**.335**	**.431**	**.426**	**.392**	.275	.198	**.472**	1																				
10	.152	.255	.276	.233	.246	.272	.192	.267	**.374**	1																			
11	.201	**.340**	**.360**	.247	.256	.150	.089	.296	.283	**.299**	1																		
12	.241	**.326**	**.400**	.247	.270	.175	.103	.278	**.291**	.249	**.625**	1																	
13	.205	**.338**	**.381**	.245	**.324**	.212	.161	**.373**	**.325**	.253	**.598**	**.637**	1																
14	.180	.248	**.322**	.205	.200	.131	.170	.222	**.331**	.257	.264	.239	.253	1															
15	.247	**.305**	**.377**	.223	.251	.137	.160	.276	**.384**	.264	**.398**	**.393**	**.364**	**.641**	1														
16	.235	.277	**.312**	.253	.223	.134	.226	.211	**.340**	**.305**	**.332**	**.354**	**.319**	**.556**	**.586**	1													
17	.225	**.332**	**.315**	.287	**.316**	.244	.205	**.403**	**.369**	**.304**	.287	**.291**	.260	.238	.279	**.303**	1												
18	.214	**.361**	**.454**	**.328**	**.364**	.193	.154	**.431**	**.406**	.253	**.377**	**.411**	**.420**	.287	**.396**	**.331**	**.455**	1											
19	**.320**	**.380**	**.452**	**.375**	**.389**	.267	.244	**.376**	**.404**	.238	**.412**	**.471**	**.416**	**.316**	**.548**	**.421**	**.359**	**.565**	1										
20	.200	**.313**	.271	.235	.276	.198	.165	**.368**	**.303**	.211	**.303**	**.400**	**.400**	.113	.265	.170	.265	**.335**	**.387**	1									
21	.330	**.430**	**.431**	**.468**	**.455**	.255	.198	**.462**	**.396**	.235	**.360**	**.382**	**.396**	.203	**.324**	.274	**.404**	**.482**	**.530**	**.454**	1								
22	.283	**.362**	**.350**	**.413**	**.397**	.210	.190	**.406**	**.389**	.222	**.302**	**.396**	**.372**	.157	.276	.236	**.349**	**.418**	**.461**	**.489**	**.680**	1							
23	.168	.253	.266	**.291**	**.318**	.272	.221	**.378**	**.317**	**.472**	**.301**	**.310**	**.352**	.142	.168	.210	**.292**	**.363**	**.332**	.279	**.369**	**.343**	1						
24	.275	**.342**	**.406**	**.363**	**.438**	.281	.206	**.495**	**.409**	**.309**	**.370**	**.376**	**.401**	.168	**.307**	.283	**.401**	**.445**	**.465**	**.374**	**.466**	**.457**	**.496**	1					
25	.080	-.116	-.122	-.078	-.120	-.031	.068	-.148	-.069	-.007	-142	-.101	-.113	-.220	-.128	-.118	-.173	-.208	-.078	.053	-.079	-.037	-.011	-.060	1				
26	.058	-.112	-.136	-.043	-.102	-.072	.112	-.177	-.109	.015	-.148	-.104	-.128	-.200	-.119	-.086	-.153	-.210	-.054	.037	-.086	-.042	-.023	-.097	**.784**	1			
27	.174	.236	**.353**	**.394**	**.444**	.221	.135	**.459**	**.442**	.194	.239	.269	.263	.210	.229	.242	**.342**	**.350**	**.351**	.256	**.431**	**.404**	**.309**	**.423**	-.093	-.115	1		
28	.151	.195	**.330**	.235	**.381**	.217	.113	**.393**	**.356**	.227	.232	.284	.282	.171	.217	.172	.288	**.314**	.287	.245	**.370**	**.366**	.264	**.376**	-.102	-.127	**.620**	1	
29	.176	**.310**	**.348**	**.399**	**.350**	.167	.119	**.405**	**.484**	.209	**.316**	**.315**	**.323**	.201	**.294**	.261	**.303**	**.345**	**.362**	.242	**.434**	**.410**	.222	**.385**	-.136	-.161	**.528**	**.460**	1

Table 7. Corrected item-total correlation of the standardized items

Quality factor	Dimension	No. item	Corrected item-total correlation	Cronbach's alpha, if item was deleted
Motivation	Attention	1	.384	.914
		2	.520	.912
		3	.599	.911
	Relevance	4	.499	.913
		5	.555	.912
		6	.351	.914
	Confidence	7	.350	.915
		8	.612	.911
	Satisfaction	9	.636	.910
		10	.416	.914
User Experience	Immersion	11	.519	.912
		12	.577	.911
		13	.592	.911
	Social Interaction	14	.378	.914
		15	.527	.912
		16	.467	.913
	Challenge	17	.528	.912
		18	.614	.910
	Fun	19	.664	.910
		20	.526	.912
		21	.692	.909
		22	.639	.910
	Competence	23	.503	.912
		24	.637	.910
	Digital Game	25	*-.098*	.919
		26	*-.124*	.920
Learning	Short-term Learning	27	.580	.911
		28	.504	.912
	Long-term Learning	29	.557	.912

AQ3: How do underlying factors influence the responses on the items of the MEEGA questionnaire?

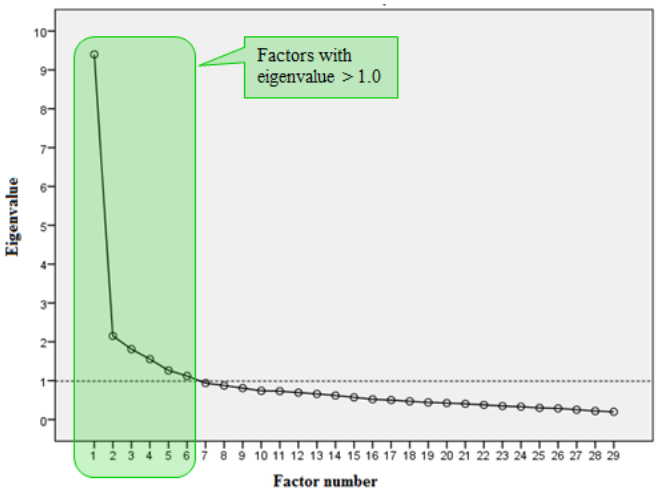

Figure 1. Scree Plot

Table 8. Factor Loadings

Quality factor	Dimension	No.	Description	Factor					
				1	2	3	4	5	6
Motivation	Attention	1	The game design is attractive	.045	.082	.668	.092	.037	.101
		2	There was something interesting at the beginning of the game that captured my attention	.108	.224	.625	.118	.163	-.119
		3	The variation (form, content or activities) helped me to keep attention to the game	.260	.288	.461	.226	.181	-.116
	Relevance	4	The game content is relevant to my interests	.484	-.028	.418	.086	.152	.025
		5	The way the game works suits my way of learning	.554	.093	.274	.015	.298	-.099
		6	The game content is connected to other knowledge I already had	.155	-.015	.253	-.041	.559	-.085
	Confidence	7	It was easy to understand the game and start using it as study material	.098	-.117	.368	.221	.393	.205
		8	Passing through the game, I felt confident that I was learning	.557	.182	.247	.057	.337	-.147
	Satisfaction	9	I am satisfied because I know I will have opportunities to use in practice things I learned playing this game	.586	.082	.238	.259	.300	-.008
		10	It is due to my personal effort that I manage to advance in the game	.117	.209	-.059	.203	.727	.084
User Experience	Immersion	11	Temporarily I forgot about my daily; I have been fully concentrated on the game	.106	.790	.088	.170	.130	-.085
		12	I did not notice the time pass while playing; when I saw the game had already ended	.166	.819	.168	.140	.078	-.036
		13	I felt myself more in the game context than real life, forgetting what was around me	.186	.768	.176	.129	.155	-.055
	Social Interaction	14	I was able to interact with others during the game	.081	.049	.082	.846	.091	-.180
		15	I had fun with other people	.149	.250	.190	.821	.019	-.050
		16	The game promotes cooperation and/or competition among the	.147	.145	.146	.778	.094	-.019

			players						
	Challenge	17	This game is appropriately challenging for me, the tasks are not too easy nor too difficult	.345	.125	.285	.207	.311	-.175
		18	The game progresses at an adequate pace and does not become monotonous - offers new obstacles, situations or variations in its tasks	.277	.351	.382	.225	.240	-.222
	Fun	19	I had fun with the game	.269	.363	.487	.345	.115	.007
		20	When interrupted at the end of the class, I was disappointed that the game was over	.263	.467	.400	.004	.063	.129
		21	I would recommend this game to my colleagues	.508	.248	.574	.087	.081	.003
		22	I would like to play this game again	.506	.273	.496	.085	.024	.047
	Competence	23	I achieved the goals of the game applying my knowledge	.231	.298	.073	.011	.685	.019
		24	I had positive feelings on the efficiency of this game	.427	.361	.306	.012	.349	-.020
	Digital game	25	The controls to perform actions in the game responded well	-.040	-.022	-.001	-.124	.003	.905
		26	It's easy to learn how to use the interface and game controls	-.115	-.070	.040	-.083	.019	.908
Learning	Short-term learning	27	The game contributed to my learning in this course	.820	.095	.077	.104	.120	-.017
		28	The game was efficient for my learning, comparing it with other activities of the course	.768	.175	-.055	.084	.094	-.037
	Long-term learning	29	The experience with the game will contribute to my professional performance in practice	.726	.189	.139	.119	.002	-.071