

Appendix A. Gamification Taxonomy

Gamification taxonomy with descriptions by Toda et al. (2019a) and dimensions by Toda et al. (2019b):

Concept	Description	Dimension
Acknowledgement	Type of feedback that praises the players' specific actions. Some examples and synonyms are badges, medals, trophies.	Performance
Chance	Randomness and probability properties that increase or decrease the odds of certain events; examples/synonyms: randomness, luck, fortune.	Ecological
Competition	When two or more players compete against each other towards a common goal; examples/synonyms: Player vs Player, scoreboards, conflict.	Social
Cooperation	When two or more players collaborate to achieve a common goal; examples/synonyms: teamwork, co-op missions.	Social
Economy	Transactions within the game, monetizing game values and other elements; examples/synonyms: markets, transaction, exchange.	Ecological
Imposed Choice	Decisions that the player is obliged to make in order to advance the game; examples/synonyms: judgements, forced choices (different from Narrative).	Ecological
Level	Hierarchical game layers, providing a gradual way for players to obtain new advantages upon advancing; examples/synonyms: character levels, skill level.	Performance
Narrative	Order of events happening in a game; i.e., choices influenced by player actions; examples/synonyms: strategies the player uses to go through a level (stealth or action), also the good/bad actions influencing the ending, karma system (different from Imposed Choice).	Fiction
Novelty	New, updated information presented to the player continuously; examples/synonyms: changes, surprises, updates.	Personal
Objectives	Guide the players' actions. Quantifiable or spatial, from short- to long-term; examples/synonyms are missions, quests, milestones.	Personal
Point	Unit used to measure users' performance; examples/synonyms: scores, number of kills, experience points.	Performance
Progression	This allows players to locate themselves (and their progress) within a game; examples/synonyms: progress bars, maps, steps.	Performance
Puzzles	Challenges within the game that should make a player think; examples/synonyms: actual puzzles, cognitive tasks, mysteries.	Personal
Rarity	Limited resources and collectables; examples/synonyms: limited items, rarity, collection.	Ecological
Renovation	When players can redo/restart an action; examples/synonyms are extra life, boosts, renewal.	Personal
Reputation	Player titles to accumulate in-game; examples/synonyms: titles, status, classification.	Social
Sensation	Use of players' senses to create new experiences; examples/synonyms: visual stimulation, sound stimulation.	Personal

Social Pressure	Pressure through social interactions with another player(s) (playable and non-playable); examples/synonyms: peer pressure, guilds.	Social
Stats	Visible information for the player, about their in-game outcomes; examples/synonyms: results, health bar, magic bar, HUD, indicators, data from the game presented to the user.	Personal
Storytelling	The way the story of the game is told (as a script) within the game, via text, voice, or sensorial resources; examples/synonyms: stories told through animated scenes, audio queues or in-game text queues.	Fiction
Time Pressure	Pressure through time in-game; examples/synonyms: countdowns, clock, timer.	Ecological

Toda, A. M., Cristea, A. I., Oliveira, W., Klock, A. C., Palomino, P. T., Pimenta, M., Gasparini, I., Shi, L., Bittencourt, I., & Isotani, S. (2019a). A Taxonomy of Game Elements for Gamification in Educational Contexts: Proposal and Evaluation. In *2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT)* (pp. 84–88). IEEE. <https://doi.org/10.1109/ICALT.2019.00028>

Toda, A. M., Klock, A. C. T., Oliveira, W., Palomino, P. T., Rodrigues, L., Shi, L., Bittencourt, I., Gasparini, I., Isotani, S., & Cristea, A. I. (2019b). Analysing gamification elements in educational environments using an existing Gamification taxonomy. *Smart Learning Environments*, 6(1). <https://doi.org/10.1186/s40561-019-0106-1>

Appendix B. Frequency of Coded Game Elements in the Consensus

Key to the Game Element Abbreviation:

1...Acknowledgement	2...Chance	3...Competition	4...Cooperation	5...Economy
6...Imposed Choice	7...Level	8...Narrative	9...Novelty	10...Objective
11...Point	12...Progression	13...Puzzles	14...Rarity	15...Renovation
16...Reputation	17...Sensation	18...Social Pressure	19...Stats	20...Storytelling
21...Time Pressure				

Game Elements																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Q1	12	38	0	1	6	11	9	0	16	5	0	9	17	28	5	1	6	0	1	1	0
Q2	20	30	0	0	5	8	13	0	18	5	0	11	10	24	4	0	1	0	0	0	0
Q3	6	29	0	0	1	3	8	0	25	2	0	15	16	19	15	0	0	0	0	0	0

Appendix C. Correlation Matrices for Game Elements in the Consensus

Key to the Game Element Abbreviation:

1...Acknowledgement	2...Chance	3...Competition	4...Cooperation	5...Economy
6...Imposed Choice	7...Level	8...Narrative	9...Novelty	10...Objective
11...Point	12...Progression	13...Puzzles	14...Rarity	15...Renovation
16...Reputation	17...Sensation	18...Social Pressure	19...Stats	20...Storytelling
21...Time Pressure				

Correlations between Game Elements^a for Question 1

		G1	G2	G4	G5	G6	G7	G9	G10	G12	G13	G14	G15	G16	G17	G19
G2	r	-0,261														
	Sig. (2-tailed)	0,059														
G4	r	-0,075	-0,221													
	Sig. (2-tailed)	0,593	0,112													
G5	r	0,234	0,092	-0,050												
	Sig. (2-tailed)	0,092	0,511	0,725												
G6	r	-0,166	,322*	-0,071	0,258											
	Sig. (2-tailed)	0,236	0,019	0,614	0,063											
G7	r	-0,005	0,173	-0,063	-0,003	0,016										
	Sig. (2-tailed)	0,974	0,217	0,655	0,983	0,907										
G9	r	-0,258	0,139	-0,091	-0,105	-0,134	-0,078									
	Sig. (2-tailed)	0,063	0,319	0,516	0,453	0,339	0,576									
G10	r	,288*	-,370**	-0,045	-0,115	-0,165	-0,146	-0,072								
	Sig. (2-tailed)	0,036	0,006	0,750	0,411	0,237	0,297	0,610								
G12	r	,356**	-0,162	-0,063	-0,162	-0,108	-0,071	-0,078	,542**							
	Sig. (2-tailed)	0,009	0,246	0,655	0,248	0,443	0,615	0,576	0,000							
G13	r	0,015	-0,107	-0,095	0,137	0,246	-0,203	-,364**	-0,083	-0,203						
	Sig. (2-tailed)	0,917	0,447	0,497	0,327	0,075	0,145	0,007	0,552	0,145						
G14	r	-0,211	,581**	-0,147	0,218	,297*	0,226	0,127	-,342*	-,277*	-0,241					
	Sig. (2-tailed)	0,129	0,000	0,294	0,116	0,031	0,104	0,363	0,012	0,044	0,082					
G15	r	-0,175	0,203	-0,045	0,088	-0,006	0,026	,350*	-0,104	0,026	-0,083	0,046				
	Sig. (2-tailed)	0,211	0,145	0,750	0,529	0,966	0,854	0,010	0,458	0,854	0,552	0,742				
G16	r	0,256	-0,221	-0,019	-0,050	-0,071	-0,063	-0,091	,430**	,307*	-0,095	-0,147	-0,045			
	Sig. (2-tailed)	0,064	0,112	0,891	0,725	0,614	0,655	0,516	0,001	0,026	0,497	0,294	0,750			
G17	r	-0,193	-0,040	,388**	-0,128	-0,036	-0,003	-0,105	-0,115	-0,003	-0,118	-0,020	-0,115	-0,050		
	Sig. (2-tailed)	0,166	0,777	0,004	0,362	0,798	0,983	0,453	0,411	0,983	0,400	0,886	0,411	0,725		
G19	r	-0,075	0,087	-0,019	-0,050	-0,071	-0,063	-0,091	-0,045	,307*	-0,095	-0,147	-0,045	-0,019	,388**	
	Sig. (2-tailed)	0,593	0,535	0,891	0,725	0,614	0,655	0,516	0,750	0,026	0,497	0,294	0,750	0,891	0,004	
G20	r	-0,075	-0,221	-0,019	-0,050	-0,071	-0,063	-0,091	-0,045	-0,063	0,202	-0,147	-0,045	-0,019	,388**	-0,019
	Sig. (2-tailed)	0,593	0,112	0,891	0,725	0,614	0,655	0,516	0,750	0,655	0,147	0,294	0,750	0,891	0,004	0,891

*. Correlation is significant at the 0.05 level (2-tailed).

**.. Correlation is significant at the 0.01 level (2-tailed).

a. Game elements that were not assigned in this set were excluded

Correlations between Game Elements^a for Question 2

		G1	G2	G5	G6	G7	G9	G10	G12	G13	G14	G15
G2	r	-,307*										
	Sig. (2-tailed)	0,028										
G5	r	-0,130	0,276									
	Sig. (2-tailed)	0,364	0,050									
G6	r	-0,015	0,251	,583**								
	Sig. (2-tailed)	0,916	0,075	0,000								
G7	r	-0,193	,307*	0,261	0,119							
	Sig. (2-tailed)	0,174	0,029	0,064	0,406							
G9	r	-0,173	,451**	-0,243	-0,093	-,338*						
	Sig. (2-tailed)	0,225	0,001	0,085	0,517	0,015						
G10	r	,410**	-0,260	-0,109	-0,142	-0,193	-0,106					
	Sig. (2-tailed)	0,003	0,065	0,448	0,320	0,175	0,461					
G12	r	,360**	-,433**	-0,013	0,036	0,021	-,387**	,308*				
	Sig. (2-tailed)	0,009	0,002	0,930	0,802	0,881	0,005	0,028				
G13	r	-0,194	,313*	,335*	0,194	,278*	0,049	-0,163	-0,019			
	Sig. (2-tailed)	0,172	0,025	0,016	0,172	0,048	0,735	0,254	0,896			
G14	r	-0,194	,470**	0,085	0,241	0,170	0,208	-0,047	-0,208	0,128		
	Sig. (2-tailed)	0,172	0,001	0,551	0,088	0,234	0,143	0,745	0,143	0,371		
G15	r	-0,085	-0,052	-0,096	0,075	-0,171	-0,063	0,149	0,024	-0,144	-0,129	
	Sig. (2-tailed)	0,553	0,715	0,502	0,602	0,231	0,661	0,296	0,865	0,313	0,367	
G17	r	0,176	-0,169	-0,047	-0,061	-0,083	-0,104	-0,047	0,270	-0,070	-0,133	-0,041
	Sig. (2-tailed)	0,217	0,236	0,745	0,671	0,564	0,466	0,745	0,056	0,626	0,351	0,774

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

a. Game elements that were not assigned in this set were excluded

Correlations between Game Elements^a for Question 3

		G1	G2	G5	G6	G7	G9	G10	G12	G13	G14
G2	r	-,323*									
	Sig. (2-tailed)	0,024									
G5	r	-0,054	0,120								
	Sig. (2-tailed)	0,713	0,412								
G6	r	-0,095	0,212	,565**							
	Sig. (2-tailed)	0,514	0,143	0,000							
G7	r	0,003	-0,195	,327*	0,118						
	Sig. (2-tailed)	0,981	0,180	0,022	0,421						
G9	r	-0,132	,598**	0,141	0,250	-0,009					
	Sig. (2-tailed)	0,365	0,000	0,332	0,083	0,951					
G10	r	0,238	-0,039	-0,030	-0,053	-0,091	-0,004				
	Sig. (2-tailed)	0,100	0,793	0,839	0,719	0,533	0,977				
G12	r	0,022	-0,169	-0,096	0,015	,425**	-0,146	-0,137			
	Sig. (2-tailed)	0,880	0,245	0,512	0,918	0,002	0,315	0,348			
G13	r	-0,127	0,224	0,207	0,185	-0,072	-0,101	,296*	-0,179		
	Sig. (2-tailed)	0,383	0,122	0,153	0,203	0,623	0,489	0,039	0,218		
G14	r	-,297*	,661**	0,181	0,146	-0,012	0,277	-0,164	0,017	0,250	
	Sig. (2-tailed)	0,038	0,000	0,212	0,316	0,937	0,054	0,260	0,909	0,084	
G15	r	-0,113	-0,169	0,217	,384**	-0,054	0,119	0,087	-0,153	0,010	-0,256

Sig. (2-tailed)	0,439	0,245	0,134	0,006	0,714	0,414	0,553	0,294	0,948	0,076
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*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

a. Game elements that were not assigned in this set were excluded