

Appendices

Appendix A (Chapter 2)

Table 2.2. Constructs and items in the questionnaire

Constructs	Items
In daily life	FTT1: I use video platforms (e.g., YouTube, TikTok) to watch or upload content. FTT2: I use social media (e.g., Instagram, Facebook, Twitter) for personal or professional use. FTT3: I use messaging apps (e.g., WhatsApp, Messenger, iMessage) for chatting with friends or family. FTT4: I use email (e.g., Gmail, Outlook) for personal, work, or academic purposes. FTT5: I use professional networking sites (e.g., LinkedIn, personal websites) to connect with colleagues or showcase work. FTT6: I use blogs or online forums (e.g., Reddit, Medium) to read or share ideas and opinions. FTT7: I use online games (e.g., mobile games, PC/console games) to play with others or alone. FTT8: I use learning platforms or apps (e.g., Coursera, Khan Academy, Duolingo) to learn new skills.
Frequency of using technological tools (FTT)	
In learning contexts	FTT9: I use learning management systems (e.g., Moodle, Canvas, Google Classroom) for accessing course materials and submitting assignments. FTT10: I use video conferencing tools (e.g., Zoom, Microsoft Teams, Google Meet) for attending or participating in virtual classes and meetings. FTT11: I use online collaboration tools (e.g., Google Docs, Microsoft OneDrive, Padlet) for group projects or sharing resources with classmates. FTT12: I use digital presentation tools (e.g., PowerPoint, Prezi, Canva) for creating and delivering educational presentations. FTT13: I use educational video platforms (e.g., YouTube Edu, Khan Academy) for watching instructional videos or tutorials. FTT14: I use gamified apps and websites (applications that turn learning or tasks into a game, e.g., where you earn points, rewards, or unlock levels during your study) for practice and self-

			assessment (e.g., Quizlet, Kahoot, Socrative).
			FTT15: I use data analysis tools (e.g., Excel, Google Sheets, SPSS) for organizing, analyzing, or visualizing data for assignments or research projects.
			FTT16: I use notetaking and organization tools (e.g., Notion, Evernote, OneNote) for managing study materials, tasks, or notes.
		Game type preference (GT)	GT1. Puzzle-based games
			GT2. Simulation-based games
			GT3. Adventure games
			GT4. Strategy games
			GT5. Role-play games
			GT6. Other
	Game design	Challenge	DP1. Games that provide me with challenges at various adjustable difficulty levels.
	principle		DP2. Games that provide me with simple challenges over complex challenges.
	preference (DP)		DP3. Games that provide me with enough time to solve challenges.
			DP4. Games that raise my curiosity by interesting and unpredictable challenges.
			DP5. Games that could allow challenges to be repeated.
		Control	DP6. Games with operating modes that fit my habits and situations (e.g., touchscreen for mobile phone; controllers for consoles).
			DP7: Games with sensitive and accurate operating modes (e.g., avoiding delayed jumping).
			DP8: Games with consistent operating rules (e.g., avoiding pressing A to jump one day and pressing B to jump the next).
			DP9: Games with simple operating modes (e.g., X to confirm; O to cancel).
			DP11: Games that allow me to personalize operating modes (e.g., adjusting the sensitivity of keyboards).
			DP12: Games that could provide me with freedom to make choices (e.g., alternative paths to reach a goal).

Creativity	DP13: Games that allow me to create game content.
	DP14: Games that provide me with creative ways to solve challenges.
	DP15: Games that allow me to modify the game system.
Exploration	DP16: Games that support my freedom of exploration and experimentation.
	DP17: Games that provide me with multiple paths/options.
	DP18: Games that provide me with an interactive game map of sufficient detail.
Fairness	DP19: Games that implement mechanisms to prevent or detect cheating.
	DP20: Games that ensure similar opportunities for success regardless of experience.
Feedback	DP21: Games that provide me with instructions and/or tutorials.
	DP22: Games that provide me with immediate feedback.
	DP23: Games that provide me with positive feedback.
	DP24: Games that provide me with useful feedback.
	DP25: Games that provide me with clear feedback.
	DP26: Games that provide me with access to my performance data.
Goals	DP27: Games that create clear goals.
	DP28: Games that create meaningful goals.
	DP29: Games that create achievable goals.
	DP30: Games that create progressive goals that build on each other.
Learning	DP31: Games that provide me with relevant learning content and activities.
	DP32: Games that provide me with some learning challenges.

		DP33: Games that embed assessment tools.
		DP34: Games that choose an appropriate transparency level for my learning content.
		DP35: Games that provide me with time to reflect amid intense game moments.
		DP36: Games that use an avatar that I can own and can relate to.
Profile Ownership	and	DP37: Games that provide me with the status of the game process and next available actions.
		DP38: Games that provide me with the past, present, and future perspectives of my knowledge, skills and behaviors.
		DP39: Games that relate to my daily life.
		DP40: Games that relate to my familiar activities.
		DP41: Games that relate to my past experiences.
Relevance Relatedness	and	DP42: Games that develop a virtual economy to allow me to trade and use resources.
		DP43: Games that allow me to collect virtual goods.
Resources Economy	and	DP44: Games that encourage me to work hard to achieve rare resources.
		DP45: Games that remind me of the risk of losing my resources.
		DP46: Games that provide me with means for social communication and interaction.
		DP47: Games that provide me with opportunities for competition.
Social Play		DP48: Games that provide me with opportunities for collaboration.
		DP49: Games that provide me with means for expressing my status among players.
		DP50: Games that provide me with means for expressing my recognition among players.
		DP51: Games that allow me to form and manage groups.
		DP52: Games that allow me to distinguish myself in my group.

Storytelling and Fantasy	DP53: Games that create a meaningful story that relates to my real life.
	DP54: Games that provide me with a fantasy context.
	DP55: Games that provide me with role-play experiences.
	DP56: Games that create possibilities for me to take part in the story.
	DP57: Games that allow me to create my own stories.
	DP58: Games that create scenarios that make me think deeply.
Performance Expectancy	PE1. I find digital games useful in my learning. PE2. Using digital games in class could increase my chances of achieving things that are important to me. PE3. Using digital games in class could help me accomplish assignments more quickly. PE4. Using digital games in class could increase my productivity.
Effort Expectancy	EE1. Learning how to use digital games is easy for me. EE2. The rules of digital games are clear and understandable. EE3. I find digital games easy to use. EE4. It is easy for me to become skillful at using digital games.
Social influence	SI1. My teachers support the idea that I use digital games in class. SI2. My peers support the idea that I use digital games in class. SI3. Students in my classes would be willing to adopt digital games. SI4. My teachers are in favor of using digital games in class. SI5. My peers are in favor of using digital games in class.
Facilitating conditions	FC1. My university has adequate infrastructure (power, internet, devices etc.) to support the use of

	digital games in class.
	FC2. I can get help from others when I have difficulties using digital games in class.
	FC3. I have the knowledge necessary to use digital games.
Learning motivation	LM1 . Using digital games is interesting.
	LM2. Using digital games makes me happy.
	LM3. I feel good when using digital games.
Learning compatibility	LC1. Using digital games fits the way I learn.
	LC2. Using digital games is completely compatible with my current learning situation.
	LC3. I think using digital games fits well with the way I like to conduct learning activities.
	LC4. Using digital games is compatible with my current learning goals.
Acceptance of using digital games in class	ADG1. I would be glad to use digital games in class regularly.
	ADG2. I would be glad to use digital games in class frequently.
	ADG3. I would be glad to use digital games in class to expand my knowledge.
	ADG4. I would be glad to use digital games in class to monitor my learning progress.
	ADG5. I would be glad to use digital games in class to seek information and tips.
	ADG6. I would be glad to use digital games in class to expand my learning opportunities.
	ADG7. I would be glad to use digital games in class to help express my thoughts.
	ADG8. I would be glad to use digital games in class to sustain my motivation for learning.
	ADG9. I would be glad to use digital games in class to ask for support and help.
	ADG10. I would be glad to use digital games to collaborate with other users in class.

Table 2.3. Descriptions and sources of key variables in UTAUT model

Variables	Abbr.	Descriptions	Items	Sources
Performance expectancy	PE	The degree to which an individual believes that using a technology will benefit them when performing specific tasks	4	Venkatesh et al. (2003)
Effort expectancy	EE	The degree of ease in using a system	4	Venkatesh et al. (2016)
Social influence	SI	The extent to which an individual user believes that important others (e.g., peers and teachers) think he/she should use a new information system or technology	5	Cheon (2012)
Facilitating condition	FC	To the degree to which an individual perceives that the available organizational and technical infrastructure can support the use of a system	3	Venkatesh et al. (2003)
Learning motivation	LM	The psychological drive that initiates, directs, and sustains a person's efforts toward engaging in learning activities.	3	Venkatesh et al. (2003)
Technology acceptance	TA	The degree to which university students intend to accept using digital games in class.	11	Lai et al. (2022)

Appendix A(a) Interview:

Introductory comments:

- The interviewer introduced themselves and explained the purpose of the interview.
- The interviewer assured the participants about anonymity and confidentiality of the research process.
- The interviewer asked for consent of the participants to record the interview.

The main body of the interview:

(we used follow-up questions to probe each question until the topic was exhausted)

- What specific advantages do you see in games to enhance learning? (e.g. knowledge retention, depth of understanding, practical skills, etc.)
- Do you think that games can help you achieve your personal learning goals (e.g. passing exams, mastering skills) more than traditional learning methods? Why?
- When you first used games for learning, how difficult did you find it to learn the rules and interface design?
- If using it for learning in class, do you think it will consume a lot of your energy?
- Do your teachers explicitly support the use of games in the classroom? How does their attitudes affect your acceptance?
- Is there a group of your classmates who have a positive or negative attitude towards games for learning? Do they influence your choices?
- Have you ever tried a game for learning due to a recommendation from a classmate or teacher? How was the experience?
- Does your school provide enough devices (e.g. tablets, computers) and network support to run games in classrooms?
- What other resources or policies do you think your school needs to better promote games for learning?
- Will using games increase your classroom engagement and interest in learning and why?
- What design elements (e.g., badge, challenge, music) of games do you find most interesting?
- What aspects of games would you like to see better adapted to your learning needs in the future?
- Would you accept if games were used in future courses? Why?
- What concerns do you have about the long-term use of games in class (e.g., distraction, technology dependency)? How can they be improved?

Preclosure (summary):

- Would you like to add something besides the questions asked already?
- Summarize the main points that might have come up during the interview.

Closure:

- The interviewer appreciates the participants taking time to respond to questions.
- The interviewer takes notes if the participants have additional remarks when off recording.

Table 2.5. Convergent validity and internal reliability

Factor	Item	Factor loading	S.E.	C.R.	AVE	Cronbach's a
EDT	EDT1	0.745	-	0.95	0.544	0.950
EDT	EDT2	0.716	0.050			
EDT	EDT3	0.703	0.051			
EDT	EDT4	0.757	0.051			
EDT	EDT5	0.731	0.052			
EDT	EDT6	0.722	0.051			
EDT	EDT7	0.755	0.052			
EDT	EDT8	0.754	0.051			
EDT	EDT9	0.738	0.051			
EDT	EDT10	0.747	0.052			
EDT	EDT11	0.767	0.052			
EDT	EDT12	0.730	0.052			
EDT	EDT13	0.751	0.051			
EDT	EDT14	0.715	0.051			

EDT	EDT15	0.733	0.052			
EDT	EDT16	0.729	0.051			
PDG	PDG1	0.745	-	0.986	0.556	0.986
PDG	PDG2	0.748	0.051			
PDG	PDG3	0.734	0.051			
PDG	PDG4	0.746	0.052			
PDG	PDG5	0.743	0.051			
PDG	PDG6	0.744	0.053			
PDG	PDG7	0.749	0.052			
PDG	PDG8	0.737	0.052			
PDG	PDG9	0.746	0.051			
PDG	PDG10	0.745	0.051			
PDG	PDG11	0.728	0.051			
PDG	PDG12	0.736	0.051			
PDG	PDG13	0.751	0.052			

PDG	PDG14	0.746	0.052
PDG	PDG15	0.725	0.051
PDG	PDG16	0.761	0.052
PDG	PDG17	0.766	0.051
PDG	PDG18	0.771	0.052
PDG	PDG19	0.772	0.052
PDG	PDG20	0.758	0.051
PDG	PDG21	0.724	0.049
PDG	PDG22	0.736	0.051
PDG	PDG23	0.721	0.051
PDG	PDG24	0.735	0.051
PDG	PDG25	0.744	0.051
PDG	PDG26	0.755	0.051
PDG	PDG27	0.744	0.052
PDG	PDG28	0.757	0.052

PDG	PDG29	0.760	0.052
PDG	PDG30	0.750	0.052
PDG	PDG31	0.765	0.052
PDG	PDG32	0.750	0.051
PDG	PDG33	0.761	0.051
PDG	PDG34	0.745	0.051
PDG	PDG35	0.743	0.050
PDG	PDG36	0.740	0.052
PDG	PDG37	0.767	0.052
PDG	PDG38	0.753	0.052
PDG	PDG39	0.762	0.052
PDG	PDG40	0.730	0.051
PDG	PDG41	0.723	0.051
PDG	PDG42	0.732	0.051
PDG	PDG43	0.746	0.050

PDG	PDG44	0.757	0.052			
PDG	PDG45	0.742	0.051			
PDG	PDG46	0.723	0.050			
PDG	PDG47	0.742	0.051			
PDG	PDG48	0.738	0.052			
PDG	PDG49	0.713	0.053			
PDG	PDG50	0.764	0.053			
PDG	PDG51	0.767	0.052			
PDG	PDG52	0.723	0.051			
PDG	PDG53	0.736	0.051			
PDG	PDG54	0.738	0.052			
PDG	PDG55	0.740	0.052			
PDG	PDG56	0.757	0.052			
PDG	PDG57	0.747	0.050			
PE	PE1	0.772	-	0.859	0.603	0.859

PE	PE2	0.763	0.054			
PE	PE3	0.794	0.054			
PE	PE4	0.777	0.053			
EE	EE1	0.788	-	0.853	0.592	0.853
EE	EE2	0.752	0.052			
EE	EE3	0.762	0.051			
EE	EE4	0.774	0.051			
SI	SI1	0.734	-	0.861	0.552	0.869
SI	SI2	0.749	0.059			
SI	SI3	0.733	0.060			
SI	SI4	0.749	0.060			
SI	SI5	0.750	0.059			
FC	FC1	0.761	-	0.825	0.612	0.825
FC	FC2	0.798	0.060			
FC	FC3	0.787	0.060			

LM	LM1	0.795	-	0.836	0.629	0.836
LM	LM2	0.798	0.054			
LM	LM3	0.788	0.054			
LC	LC1	0.756	-	0.835	0.558	0.834
LC	LC2	0.725	0.058			
LC	LC3	0.761	0.059			
LC	LC4	0.747	0.058			
ADG	ADG1	0.789	-	0.941	0.593	0.941
ADG	ADG2	0.776	0.044			
ADG	ADG3	0.787	0.046			
ADG	ADG4	0.752	0.046			
ADG	ADG5	0.765	0.045			
ADG	ADG6	0.769	0.044			
ADG	ADG7	0.779	0.046			
ADG	ADG8	0.763	0.045			

ADG	ADG9	0.764	0.044
ADG	ADG10	0.779	0.045
ADG	ADG11	0.749	0.046

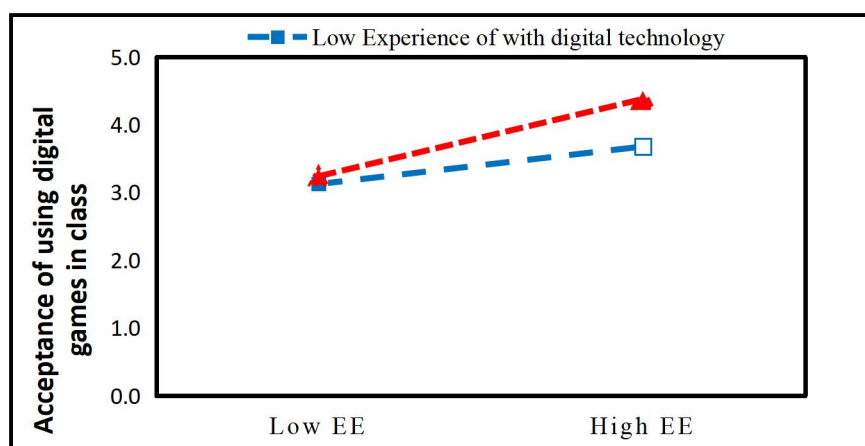
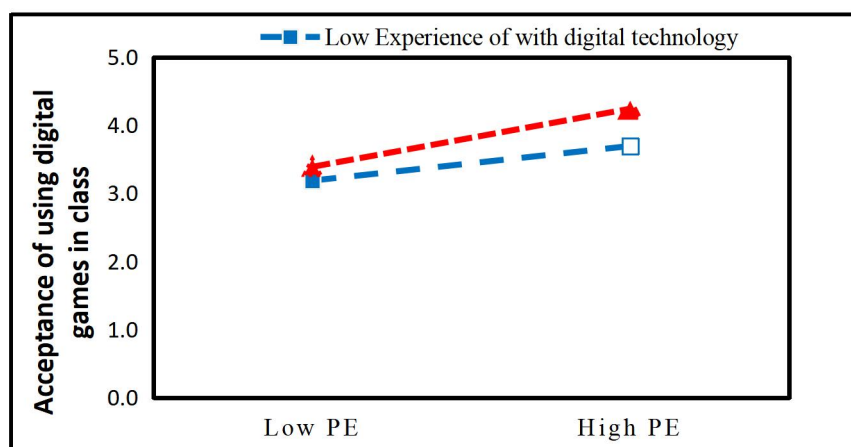
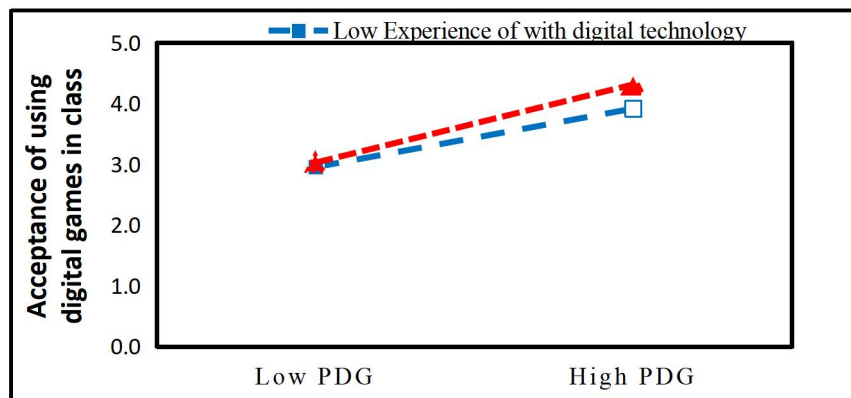
Table 2.11. Factors on acceptance of digital games yielded from interview data

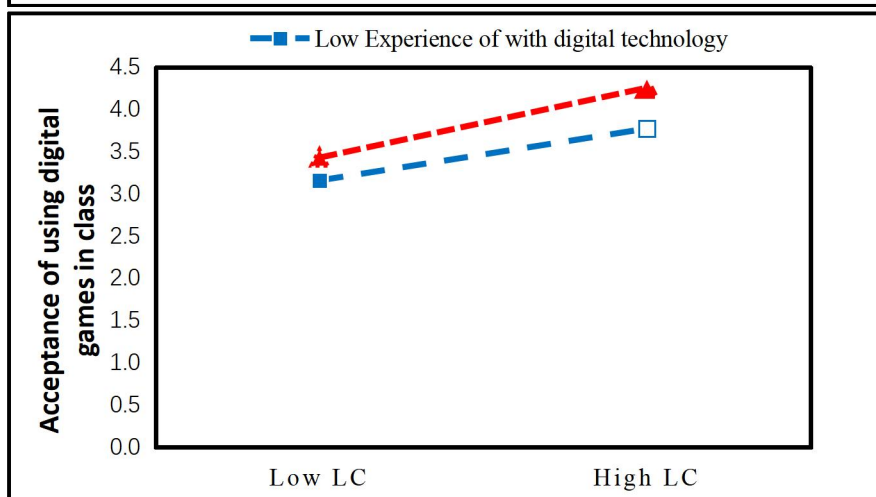
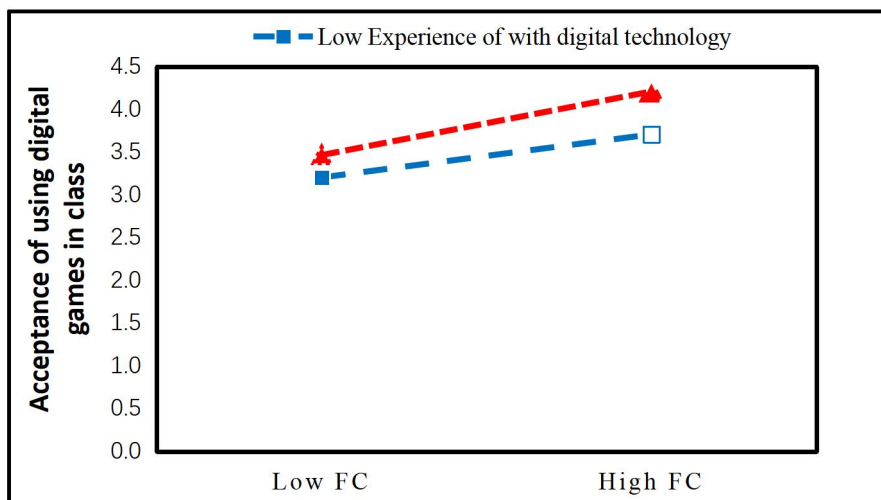
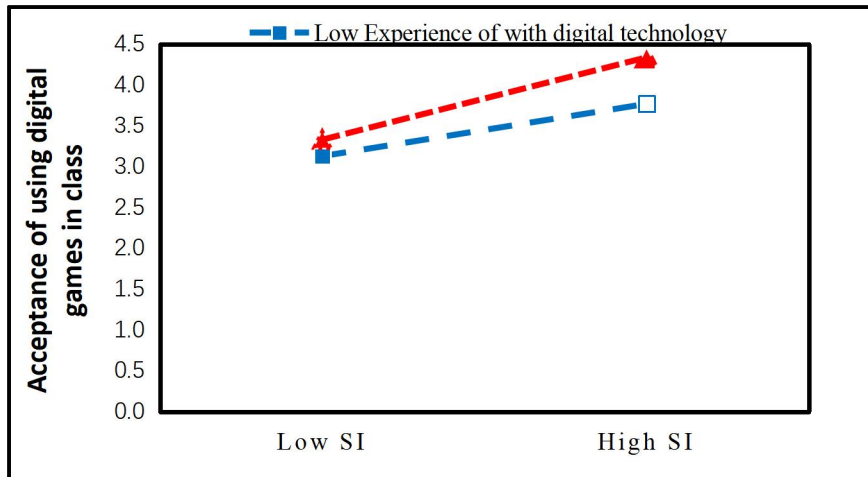
Factor	Variable	Sub-variable	Item
Adaptive game design	Fitting learning needs and avoiding over-entertainment	6. Fitting types of learning contents	Skill-based learning Knowledge-building learning Deep thinking-based learning
		7. Fitting real-world contexts	
		8. Fitting curriculum objectives	
		9. Systematic correction of errors and in-depth analysis	
		10. Knowledge export function	
	Fitting individual characteristics	1. Personalized game interface	
		2. Emphasize individual physiological experience	Eyestrain Wrist pain
		3. Dynamic difficulty adjustment	
Technical conditions and resource support	School equipment and facilities	1. High-performance computing center	
		2. Adequate quantity	
	Networking	1. Fast download speed	
		2. Campus network coverage	
	Offline learning system	Cross-platform progress synchronization system	
		Battery Life	
		Guarantee of network access	
		Relaxation of network restrictions	
Risk management	Preventing student technology dependence	Waiting for prompts and not willing to think proactively	
	Preventing student distraction	Skin/effects/music/etc. interruptions	
	Preventing game content lags and cognitive conflicts		
The key role of teachers	TPACK skill		
Pre-course pilot run and post-course	Attitude Pre-course pilot run		

evaluation
mechanism

Post-course
evaluation
mechanism

Appendix A(b) Moderated effects of prior experience on acceptance





Appendix B (Chapter 3)

Table 3.3. Reliability and convergent validity

Variables			Items	Parameters of significant test				Item Reliability (R-square)	Composite Reliability (CR)	Convergence Validity (AVE)	Cronbach's alpha
				Estimate	S.E.	Est/S.E.	p				
Game preferences	element	Reward	RE1	0.792	-		** *	0.627	0.893	0.624	0.892
			RE2	0.807	0.051	15.824	** *	0.651			
			RE3	0.771	0.052	14.827	** *	0.594			
			RE4	0.785	0.05	15.700	** *	0.616			
			RE5	0.796	0.051	15.608	** *	0.634			
	Ranking		RA1	0.826	-		** *	0.682	0.901	0.646	0.901
			RA2	0.808	0.046	17.565	** *	0.653			
			RA3	0.798	0.046	17.348	** *	0.637			
			RA4	0.784	0.045	17.422	** *	0.615			
			RA5	0.802	0.045	17.822	** *	0.643			
	Cooperation		COO1	0.783	-		** *	0.613	0.879	0.593	0.879
			COO2	0.763	0.054	14.130	** *	0.582			
			COO3	0.77	0.054	14.259	**	0.593			

Competition	COO4	0.768	0.055	13.964	*	0.590	0.872	0.576	0.872
	COO5	0.767	0.055	13.945	**	0.588			
	COM1	0.772	-		*	0.596			
	COM2	0.748	0.059	12.678	**	0.560			
	COM3	0.765	0.058	13.190	*	0.585			
Challenge	COM4	0.756	0.058	13.034	**	0.572	0.899	0.641	0.899
	COM5	0.754	0.056	13.464	*	0.569			
	CH1	0.817	-		**	0.667			
	CH2	0.79	0.046	17.174	*	0.624			
	CH3	0.787	0.049	16.061	**	0.619			
	CH4	0.795	0.047	16.915	*	0.632			
	CH5	0.812	0.047	17.277	**	0.659			

Table 3.3 (continued)

Variables	Items	Parameters of significant test				Item Reliability (R-square)	Composite Reliability (CR)	Convergence Validity (AVE)	Cronbach's alpha
		Estimate	S.E.	Est/S.E.	p				
Writing needs Necessities Text type	TT1	0.766	-		***	0.587	0.917	0.579	0.917

Lacks	Writing component	TT2	0.749	0.055	13.618	***	0.561	0.904	0.61	0.903
		TT3	0.771	0.057	13.526	***	0.594			
		TT4	0.781	0.057	13.702	***	0.610			
		TT5	0.748	0.057	13.123	***	0.560			
		TT6	0.758	0.056	13.536	***	0.575			
		TT7	0.743	0.054	13.759	***	0.552			
		TT8	0.72	0.056	13.786	***	0.596			
		WC1	0.769	-		***	0.591			
		WC2	0.763	0.057	13.386	***	0.582			
		WC3	0.79	0.057	13.860	***	0.624			
		WC4	0.786	0.056	14.036	***	0.618			
		WC5	0.79	0.059	13.390	***	0.624			
		WC6	0.785	0.057	13.772	***	0.616			
	Writing skill	WS1	0.742	-		***	0.551	0.95	0.595	0.95
		WS2	0.777	0.058	13.397	***	0.604			
		WS3	0.737	0.058	12.707	***	0.543			
		WS4	0.772	0.058	13.310	***	0.596			
		WS5	0.785	0.057	13.772	***	0.616			
		WS6	0.773	0.056	13.804	***	0.598			
		WS7	0.783	0.059	13.271	***	0.613			
		WS8	0.768	0.058	13.241	***	0.590			
		WS9	0.797	0.059	13.508	***	0.635			
		WS10	0.75	0.058	12.931	***	0.563			
		WS11	0.789	0.059	13.373	***	0.623			
		WS12	0.785	0.057	13.772	***	0.616			
		WS13	0.769	0.059	13.034	***	0.591			
Wants	Writing material	WM1	0.816	-		***	0.666	0.846	0.647	0.846
		WM2	0.78	0.053	14.717	***	0.608			
		WM3	0.817	0.055	14.855	***	0.667			
	Writing task	WT1	0.797	-		***	0.635	0.931	0.628	0.931
		WT2	0.778	0.049	15.878	***	0.605			

WT3	0.783	0.05	15.660	***	0.613
WT4	0.794	0.048	16.542	***	0.630
WT5	0.794	0.049	16.204	***	0.630
WT6	0.803	0.049	16.388	***	0.645
WT7	0.795	0.05	15.900	***	0.632
WT8	0.798	0.049	16.286	***	0.637

Table 3.4. Discriminant validity of student game element preferences scale

	Reward	Ranking	Cooperation	Competition	Challenge
Reward	0.790				
Ranking	0.427	0.804			
Cooperation	0.405	0.391	0.770		
Competition	0.389	0.426	0.390	0.759	
Challenge	0.401	0.419	0.368	0.417	0.800

Table 3.5. Discriminant validity of student writing needs scale

	Text type	Writing component	Writing skill	Writing material	Writing task
Text type	0.761				
Writing component	0.430	0.781			
Writing skill	0.396	0.432	0.772		
Writing material	0.353	0.416	0.427	0.804	
Writing task	0.456	0.402	0.423	0.426	0.793

Table 3.6. Descriptive statistics on game element preferences

Preferences	Variables	Mean	SD
	Reward	3.36	0.99
	Ranking	3.28	1.03
	Cooperation	3.35	0.95
	Competition	3.37	0.94
	Challenge	3.29	1.01

Table 3.8. Descriptive statistics on writing needs

	Variables	Mean	SD
Writing needs	Necessities		
	Text type	3.33	0.92
	Writing short summaries	3.33	1.15
	Writing research proposals	3.27	1.13
	Writing research papers/report	3.29	1.17
	Writing review articles	3.35	1.17
	Writing general argumentative essays	3.37	1.16
	Writing critiques	3.31	1.16
	Writing case studies	3.35	1.11
	Writing theses	3.37	1.15
	Writing component	3.31	0.98
	Grammar	3.29	1.16
	Vocabulary	3.27	1.18
	Organization	3.36	1.19
	Mechanics	3.32	1.18
	Content	3.33	1.23

Lacks	Critical thinking	3.30	1.19
	Writing skill	3.35	0.90
	Writing problem statements	3.29	1.15
	Searching for appropriate literature using databases and library resources	3.40	1.11
	Referring to sources	3.34	1.17
	Formulating scientific relevance	3.41	1.13
	Writing up the methods section	3.42	1.16
	Summarizing and presenting the findings	3.38	1.15
	Writing commentaries and discussions on the findings	3.36	1.16
	Presenting references/bibliography	3.30	1.12
	Writing conclusions	3.30	1.17
	Using appropriate lexical phrases (such as "based on", "it should be noted that") freely to build up the sentences and paragraphs	3.33	1.15
	Paraphrasing	3.39	1.14
	Writing coherent paragraphs	3.29	1.14
	Linking sentences smoothly	3.37	1.12
Wants	Writing material	3.33	1.02
	Key textbooks	3.33	1.16
	Other supplementary handouts	3.35	1.15
	Supplementary authentic research papers as models	3.31	1.17
	Writing tasks	3.31	0.99
	Individual work	3.30	1.21
	Group discussion	3.27	1.19
	Peer review tasks	3.33	1.20
	Academic grammar drills	3.33	1.18
	Academic vocabulary drills	3.31	1.19
	Academic writing exercises	3.31	1.20
	Academic reading exercises	3.32	1.22
	Analyzing authentic research papers	3.28	1.19

Table 3.10. Pearson's correlations of all measured continuous variables

		Variables	1	2	3	4	5	6	7	8	9	10
Writing needs	Necessities	Text type	1									
		Writing component	0.430* *	1								
	Lacks	Writing skill	0.396* *	0.432* *	1							
		Wants	Writing material	0.353* *	0.416* *	0.427 **	1					
		Writing task	0.456* *	0.402* *	0.423 **	0.426* *	1					
Game element preferences		Reward	0.393* *	0.452* *	0.379 **	0.334* *	0.424* *	1				
		Ranking	0.439* *	0.485* *	0.403 **	0.394* *	0.440* *	0.427* *	1			
		Cooperation	0.391* *	0.395* *	0.360 **	0.381* *	0.442* *	0.405* *	0.391* *	1		
		Competition	0.388* *	0.437* *	0.426 **	0.326* *	0.418* *	0.389* *	0.426* *	0.390**	1	
		Challenge	0.379* *	0.431* *	0.428 **	0.368* *	0.412* *	0.401* *	0.419* *	0.368**	0.417* *	1

Note: ** p<0.01

Table 3.12. Path analysis

Game element preference→writing need	Path	Standardized path coefficient	S.E.	C.R.	P
Necessities	reward→text type	0.140	0.048	2.64	0.008
	ranking→text type	0.228	0.046	4.207	***

Lacks	cooperation→text type	0.166	0.051	3.17	0.002
	competition→text type	0.141	0.054	2.601	0.009
	challenge→text type	0.123	0.046	2.36	0.018
	reward→writing component	0.190	0.048	3.707	***
	ranking→writing component	0.252	0.045	4.811	***
	cooperation→writing component	0.113	0.049	2.266	0.023
	competition→writing component	0.171	0.053	3.264	0.001
	challenge→writing component	0.155	0.045	3.076	0.002
	reward→writing skill	0.111	0.046	2.146	0.032
	ranking→writing skill	0.149	0.043	2.837	0.005
	cooperation→writing skill	0.109	0.048	2.136	0.033
	competition→writing skill	0.211	0.052	3.908	***
	challenge→writing skill	0.208	0.044	4.012	***
	reward→writing material	0.078	0.056	1.367	0.172
Wants	ranking→writing material	0.214	0.053	3.692	***
	cooperation→writing material	0.222	0.059	3.901	***
	competition→writing material	0.077	0.062	1.32	0.187
	challenge→writing material	0.169	0.053	2.999	0.003
	reward→writing task	0.154	0.051	3.011	0.003
	ranking→writing task	0.180	0.048	3.49	***
	cooperation→writing task	0.221	0.054	4.351	***
	competition→writing task	0.155	0.057	2.966	0.003
	challenge→writing task	0.142	0.049	2.834	0.005

Note. ***p < 0.001

Table 3.14. Constructs and Items in questionnaire

Constructs		Items
English Writing Needs	Text Type (TT)	TT1: Writing short summaries
		TT2: Writing research proposals
		TT3: Writing research papers/report
		TT4: Writing general argumentative essays
		TT5: Writing review articles
		TT6: Writing critiques
		TT7: Writing case studies
		TT8: Writing thesis
	Component (CN)	CN1: Grammar
		CN2: Vocabulary
		CN3: Organization
		CN4: Mechanics
	Writing Skill (WS)	CN5: Content
		CN6: Critical thinking
		WS1: Writing problem statements
		WS2: Searching for appropriate literature using databases and library resources
		WS3: Referring to sources
		WS4: Formulating scientific relevance
		WS5: Writing up the methods section
		WS6: Summarizing and presenting the findings
		WS7: Writing commentaries and discussions on the findings
		WS8: Presenting references/bibliography
		WS9: Writing conclusions
		WS10: Using appropriate lexical phrases (such as "on the basis of", "it should be noted that") freely to build up the sentences and paragraphs
	Writing Material (WM)	WS11: Paraphrasing
		WS12: Writing coherent paragraphs
		WS13: Linking sentences smoothly

Writing Task (WT)		WM1: Key textbooks WM2: Other supplementary handouts WM3: Supplementary authentic research papers as models
Game Preference	Reward (R)	WT1: Individual work WT2: Group discussion WT3: Peer review tasks WT4: Academic grammar drills WT5: Academic vocabulary drills WT6: Academic writing exercises WT7: Academic reading exercises WT8: Analyzing authentic research papers
		R1: I prefer to be rewarded if I win. R2: I will put in effort to gain rewards. R3: Rewards acknowledge my performances. R4: I feel stressed when trying to gain rewards. R5: Reward is a great way to motivate me.
	Cooperation (C)	RK1: I prefer to know my ranking in the game. RK2: I will put in effort to have a top ranking. RK3: Rankings acknowledge my performances. RK4: Rankings make me feel stressed. RK5: Rankings are a great way to motivate me.
		C1: I prefer to cooperate with others. C2: I will put effort into collaborating with my peers.
	Competition (CP)	C3: It is important to me to feel like I am part of a team. C4: Group activities make me feel stressed. C5: Cooperation is a great way to motivate me.

Challenge (CL)

CP1: I prefer to compete with others.

CP2: I will put effort in to surpass others.

CP3: Success in a competition acknowledges my performance.

CP4: Competition makes me feel stressed.

CP5: Competition is a great way to motivate me.

CL1: I prefer to overcome challenges.

CL2: I will put effort in to overcome challenges.

CL3: Overcoming challenges successfully acknowledges my performance.

CL4: Challenges make me feel stressed.

CL5: Challenges are a great way to motivate me.

Appendix C(a) References for studies included in Chapter 4

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Appendix D (Chapter 5)

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Table 4.2. Background information of the selected studies

Authors (year)	Country of Study	Type of Study	Educational Level	Application Context	Learning Environment
Abbasi et al. (2021)	Iran	Quantitative	High school	Mathematics	LMS of the Tehran math home online school
Barata et al. (2015)	Portugal	Mixed	University	Engineering	Moodle
Bennani et al. (2021)	Tunisia	Quantitative	Primary school	Science	Class quiz
Buckley & Doyle. (2017)	Ireland	Mixed	University	Business	An on-line prediction market platform
Codish & Ravid. (2014)	Israel	Quantitative	University	Software analysis and design	LMS in a semester long project
Daghestani et al. (2020)	Saudi Arabia; Egypt	Mixed	University	Computer science	Moodle
Dalmina et al. (2022)	Brazil	Mixed	-	-	GamiProM
Dumas et al. (2023)	France	Quantitative	Secondary school	Mathematics	LudiMoodle
Gil et al. (2015)	Spain; UK	Mixed	University	Computer science	-
Hallifax et al. (2020)	France	Quantitative	High school	Mathematics	LudiMoodle
Hernández et al. (2021)	Mexico	Mixed	Primary school	Mathematics	Intelligent tutoring systems
Hwang et al. (2012)	Taiwan (China)	Quantitative	Primary school	Natural science	Role playing game which employed the RPG Maker developed by Enterbrain
Jagušt et al. (2018)	Croatia; South Korea	Mixed	Primary school	Mathematics	Incorporation A custom mobile learning platform
Johnson et al. (2020)	USA	Quantitative	University	Submarine	Periscope Operator Adaptive Trainer
Kolpikova et al. (2019)	USA	Quantitative	University	Biology	Preclass reading quiz (RQ)
Madrid & de Jesus. (2021)	Philippines	Mixed	University	-	Guildhouses of Taskosmos
Maher et al.	Egypt	Mixed	University	Computer	MOOCs

(2020)					science and software engineering	
Missaoui & Maalel. (2021)	Tunisia	Mixed	-	-	-	Class quiz
Monterrat et al. (2014)	France	Mixed	-	-	-	-
Oliveira et al. (2022)	Brazil; Finland; UK; Canada	Mixed	Primary school	-	-	MeuTutor
Rodríguez et al. (2022)	Spain	Mixed	Secondary school	Science	-	Nanomoocs
Roosta et al. (2016)	Iran	Quantitative	University	Technical English	-	DoosMooc
Santos et al. (2018)	Brazil; Canada	Quantitative	Primary school	-	-	MeuTutor
Shabihi et al. (2016)	Iran	Quantitative	University	-	-	Rememry
Silva et al. (2023)	Brazil	Mixed	High school; Secondary school	English, Informatics, Geography, Religious Teaching, Portuguese, and Arts	-	Gamified logic system
Tan & Cheah. (2021)	Singapore	Mixed	University	Physics	-	AI-enabled online learning application
Welbers et al. (2019)	Netherlands	Quantitative	University	Social science	-	Knowingo
Xu et al. (2017)	China; Portugal	Mixed	University	Web design	-	SmartBand
Xiao et al. (2024)	Hong Kong (China)	Quantitative	University	Humanities and social science; science; medicine	-	-
Xiao & Hew (2024)	Hong Kong (China)	Mixed	University	Business	-	-
Zaric et al. (2017)	Montenegro; Macedonia	Mixed	University	-	-	Moodle

Table 4.3. Research methods used in selected studies

Method	Number of articles	Studies
Quantitative	13	Abbasi et al. (2021); Bennani et al. (2021); Codish & Ravid. (2014); Dumas et al. (2023); Hallifax et al. (2020); Hwang et al. (2012); Johnson et al. (2020); Kolpikova et al. (2019); Roosta et al. (2016); Santos et

Qualitative	0	al. (2018); Shabihi et al. (2016); Welbers et al. (2019); Xiao et al. (2024); -
Mixed method	18	Barata et al. (2015); Buckley & Doyle. (2017); Daghestani et al. (2020); Dalmina et al. (2022); Gil et al. (2015); Hernández et al. (2021); Jagušt et al. (2018); Madrid & de Jesus. (2021); Maher et al. (2020); Missaoui & Maalel. (2021); Monerrat et al. (2014); Oliveira et al. (2022); Rodríguez et al. (2022); Silva et al. (2023); Tan & Cheah. (2021); Xu et al. (2017); Xiao & Hew (2024); Zaric et al. (2017)

Table 5.2. An overview of tailored approaches for digital gamification in the studies reviewed

Authors	Country	Discipline	Education al level	Tailored approach	Data sources description	Analyze	Research
Barata et al. (2015)	Portugal	Engineering	University	Modeling	Observation	Machine learning	Player type-based gamification model
Bennani et al. (2020)	Tunisia	No info	No info	Modeling	Observation	Literature	AGE-Learn ontology program
Codish & Ravid (2014)	Israel	Industrial management and engineering		Modeling	Questionnaire	Literature	Personality-based gamification model
de la Peña et al. (2021)	Spain	Science, education, business management and economy, technical sciences and engineering	University	Modeling	No info	Scientific triangulation methodology	Player type-based Distance learning gamification model
Dermeval et al. (2019)	Brazil, Canada	No info	University	Modeling	Observation	Automated reason	GaTO ontology program
Dyken et al. (2021)	USA	No info	No info	Modeling	No info	No info	Unified gamification and motivation model
Gil et al. (2015)	UK	Computer science	University	Modeling	Questionnaire, observation	Literature	Player type-based model
González et al. (2016)	Spain	No info	No info	Modeling	User data, observation: login times, game duration, gamified action traces	Data mining	Gamified intelligent tutorial system based on students' multiple characteristics
Hammami & Khemaja	Tunisia	System and Data	University	Modeling	Observation	Agile methodol	Skill, competency and learning goal-based

(2019)		Integration				ogy	model
Imre (2020)	Romania	Computer science	No info	Modeling	No info	Data mining	Ontology based automatic gamified program
Klock et al. (2015)	Brazil	No info	No info	Modeling	Observation, form, survey, user data, interview	Human-computer interaction	Adapt Web program
Klock et al. (2015b)	Brazil	Computer science	University	Modeling	Questionnaire	Literature	Adapt Web program
Knutas et al. (2019)	Finland, Belgium, Italy	No info	No info	Modeling	Survey	Literature	Player type-based model
Madrid & de Jesus (2021)	Philippines	No info	No info	Modeling	No info	Literature	Player type-based model
Monterrat et al. (2014)	France	No info	No info	Modeling	Observation	Machine learning	Player type-based model
Monterrat et al. (2014b)	France	No info	No info	Modeling	User data, observation	Trace analysis	Tailored gamified system based on multiple characteristics
Monterrat et al. (2015)	France	No info	No info	Modeling	Test, questionnaire	Linear relation	Player type-based model
Rodrigues et al. (2021)	Brazil, Canada	No info	No info	Modeling	Questionnaire	Machine learning (decision tree)	Automated tailoring gamified system model

Table 5.2. (continued)

Authors	Country	Discipline	Educational level	Tailored approach	Data sources description	Analyze	Research
Santos et al. (2018)	Brazil, Canada	No info	No info	Modeling	Observation	Statistical tests (Shapiro-Wilk, Kolmogorov-Smirnov, Skewness, Kurtosis)	Player type-based model
Santos et al. (2021)	Brazil, Finland	No info	No info	Modeling	Survey	Storyboard	Player type-based model
Sezgin & Yüzer (2022)	Turkey	Education	University	Modeling	Delphi panel	Content analytics	Design principles in tailored online course
Tenório et al. (2020b)	Brazil	No info	No info	Modeling	Observation	Literature	Gamification analytics model
Tenório et al. (2021)	Brazil	No info	No info	Modeling	Observation	Literature	Gamification analytics model
Zaric et al. (2017)	Montenegro, Macedonia	No info	University	Modeling	Questionnaire	Literature	Learning style-based model
Abbasi et al. (2021)	Iran	Math	High school	Personalization	Questionnaire	Literature	Motivation and personality trait-based pretest-posttest experimental study
Buckley & Doyle (2017)	Ireland	Accounting and finance	University	Personalization	Questionnaire	No info	Learning style and personality trait-based experimental study
Eder et al.	Mexico	No info	High	Personalization	Interview	Instructors	Player-Persona-based

(2021)			school	tion		' judgment, literature	case study
Hallifax et al. (2020)	France	Math	High school	Personalization	Questionnaire	Literature	Player type and motivation type-based comparative study
Maher et al. (2020)	Egypt	No info	No info	Personalization	User data, observation: gamified action traces	Learning analytics	Experimental study based on students' multiple characteristics
Missaoui & Maalel (2021)	Tunisia	No info	No info	Personalization	Registration Form, questionnaire, observation: gamified action traces	Machine learning	Case study about SPOnTo ontology based on students' multiple characteristics
Roosta et al. (2016)	Iran	Language	University	Personalization	Questionnaire	Literature	Motivation type-based experimental study
Shabihi et al. (2016)	Iran	Language	University	Personalization	Questionnaire	Literature	Two personality trait-based personal experimental studies
Daghestani et al. (2020)	Saudi Arabia, Egypt	Data structure	No info	Adaptation	Observation : gamified action traces	Data mining	AI-enabled gamified case study based on students' player type in BrainHex typology
Hassan et al. (2021)	Pakistan	Math	No info	Adaptation	Observation : gamified action traces	Instructors', judgement, literature	FSLSM Learning style-based experimental studies
Jagušt et al. (2018)	Croatia, Korea	Math	Elementary	Adaptation	Game score, observation:	No detailed-	Comparative study based on students'

					gamified action traces	algorithm	timely behaviors and performances
Kolpikova et al. (2019)	USA	Biology	University	Adaptation	Quiz score, observation: scaffolding times	Instructors' judgment	Comparative study about adaptive pre-class quizzes based on students' timely behaviors and performances
Maher et al. (2020)	Egypt	No info	No info	Adaptation	User data, observation: gamified action traces	Learning analytics	Experimental study based on students' multiple characteristics
Missaoui & Maalel (2021)	Tunisia	No info	No info	Adaptation	Registration Form, questionnaire, observation: gamified action traces	Machine learning	Case study about SPOnTo ontology based on students' multiple characteristics
Monterrat et al. (2017)	France	Language	Secondary school	Adaptation	Observation: gamified action traces	Linear variation	BrainHex Player type-based exploratory study
Rodríguez et al. (2022)	Spain	No info	Secondary school	Adaptation	Observation: game speed, game duration, gamified action traces	Matrix multiplication method	Experimental study based on students' player type

Shi & Cristea (2016)	UK	Computer science, management	University	Adaptation	Observation: gamified action traces	Literature	SDT Motivation type-based gamified case study
Tan & Cheah (2021)	Singapore	Physics	University	Adaptation	Quiz score, time spent in quizzes, attempts for quizzes, login frequency,	Instructors' judgment, literature	AI-enabled gamified case study based on students' timely behaviors and performances
Tenório et al. (2020)	Brazil	Gamification in education	No info	Adaptation	Observation: gamified action traces	Literature	Case study about a gamification analytics tool based on students' class timely behaviors and performances
Xu et al. (2017)	China, Portugal	Computer science	University	Adaptation	Observation: bullet and shake requests for stating questions and help	Instructors' judgement, literature	Gamified case study based on students' timely behaviors and performances
Su et al. (2016)	Taiwan (China)	Math	No info	Recommendation	No info	Delphi method	A learning style-based recommendation system used experimental study

Table 5.3. An overview of game element clusters for tailored digital gamification in the studies reviewed

Authors(year)	Tailored approach	Game element clusters	Game elements	Game mechanics
Barata et al. (2015)	Modeling	Performance	Reward	Point, badge
			Progress	Level, leaderboard
			Ecological	Time pressure
			Social	Competition
			Personal	Challenge
Bennani et al. (2020)	Modeling	No info	No info	No info
Codish and Ravid (2014)	Modeling	Performance	Reward	Point, badge
			Progress	Leaderboard, progress bar
de la Peña et al. (2021)	Modeling	Performance	Reward	Point
			Progress	Card, point, level
			Ecological	Access
		Social	Chance	External resource, power
			Competition	Point, leaderboard (scoreboard, comparison table)
			Cooperation	
		Personal	Customization	
Dermeval et al. (2019)	Modeling	Performance	Reward	Badge, point
			Progress	Level
			Feedback	
		Social	Competition	Point, leaderboard
		Personal	Customization	Avatar
Dyken et al. (2021)	Modeling	Performance	Challenge	Boss fight
			Reward	Badge, gift, award
			Progress	Progress tracker, badge

Gil et al. (2015)	Modeling	Social	Voting	
			Competition	Leaderboard
			Socialization	Social comparison
		Personal	Customization	Player generated content, task complexity
			Challenge	Quest, solution identification & application
			Storytelling/story	Avatar
		Performance	Reward	Point, badge, certificate, gift
			Progress	Level
			Choice	
		Ecological	Economy/trading	
			Access	
			Competition	Point
		Social	Socialization	Social status, social networking, social discovery, mutual help and sharing
			Cooperation	Teamwork
González et al. (2016)	Modeling	Personal	Challenge	Assignment, quest
		Performance	Reward	
			Progress	
			Access	
		Ecological	Challenge	
Hammami & Khemaja (2019)	Modeling	Personal	Challenge	
			Reward	Point
			Choice	
		Ecological	Competition	Point, leaderboard
			Cooperation	
			Goal	
		Personal	Customization	Role
			Challenge	Task

Imre (2020)	Modeling	Performance	Reward	Point, badge
			Progress	Level
			Feedback	
		Social	Competition	Leaderboard
		Personal	Challenge	
		Fictional	Storytelling/story Narrative	
Klock et al. (2015)	Modeling	Performance	Reward	Point, badge
			Progress	Progress bar, level
		Social	Competition	Point, ranking
		Personal	Challenge	Task
Klock et al. (2015b)	Modeling	Performance	Reward	Badge, goods
			Progress	Level, leaderboard
		personal	Customization	
			Challenge	
Knutas et al. (2019)	Modeling	Performance	Reward	Point, badge
			Competition	
			Socialization	
		Personal	Cooperation	
			Challenge	
Madrid & de Jesus (2021)	Modeling	Performance	Reward	Point
			Progress	Milestone
		Ecological	Economy/trading	Badge
		Social	Socialization	Social status
		Personal	Customization	Avatar
			Challenge	Quest
		Fictional	Storytelling/story	
			Narrative	
Monterrat et al.	Modeling	Performance	Feedback	Tooltip

(2014)

			Social	Competition	Leaderboard
			Personal	Socialization	Tip, social network, chat
				Customization	
				Goal	
			-	Challenge	Badge, cup
Storytelling/story					
Monterrat et al. (2014b)	Modeling	Social	Competition	Leaderboard	
Monterrat et al. (2015)	Modeling	Performance	Socialization	Share button	
			Reward	Point	
			Progress	Avatar	
			Ecological	Access	
			Time pressure	Timer	
Rodrigues et al. (2021)	Modeling	Social	Socialization	Tip	
			Competition	Leaderboard	
		Performance	Reward/acknowledge ment	Point	
			Progress	Level	
		Ecological	Choice		
			Chance		
			Rarity		
			Time pressure		
			Economy/trading		
		Social	Competition		
			Socialization	Social pressure	
			Reputation		
Cooperation					
Personal	Free to fail/renovation				
	Novelty Sensation				

			Goal/objectives	
			Challenge	Puzzle
		Fictional	Storytelling/story	
			Narrative	
Santos et al. (2018)	Modeling	Performance	Reward	Point, badge, trophy
			Progress	Progress bar, level
		Social	Competition	Ranking
		Personal	Customization	Avatar
Santos et al. (2021)	Modeling	Performance	Reward	Point, trophy
			Progress	Level, progress bar, stats
		Ecological	Choice	
			Chance	
			Rarity	
			Time pressure	
			Economy/trading	
		Social	Competition	
			Socialization	Social pressure
			Reputation	Title
			Cooperation	
		Personal	Free to fail/renovation	
			Novelty Sensation	
			Goal	
			Challenge	Puzzle
		Fictional	Storytelling/story	
			Narrative	
Sezgin & Yüzer (2022)	Modeling	No info	Info	No info
Tenório et al. (2020b)	Modeling	Performance	Reward	Point, badge
			Progress	Level

Tenório et al. (2021)	Modeling		Feedback	
		Social	Competition	Leaderboard
		Personal	Challenge	
		-	Storytelling/story	
		Personal	Customization	
Zaric et al. (2017)	Modeling		Goal	
			Challenge	Mission
		Performance	Reward	Badge
			Progress	Progress bar
			Feedback	
Abbasi et al. (2021)	Personalization	Ecological	Time pressure	
		Social	Competition	
		Personal	Challenge	
		-	Storytelling/story	
		Performance	Reward	
Buckley & Doyle (2017)	Personalization		Progress	Map
			Feedback	
		Personal	Challenge	Puzzle
		Performance	Reward	Point, badge, virtual goods
		Ecological	Access	
Eder et al. (2021)	Personalization	Social	Competition	Leaderboard
			Cooperation	
			Socialization	Social network
		Personal	Customization	
			Goal	
			Challenge	
		Performance	Reward	Point
			Feedback	
		Social	Competition	

		Personal	Customization	Avatar
			Challenge	
Hallifax et al. (2020)	Personalization	Performance	Reward	Point, badge
			Progress	Level
		Ecological	Time pressure	Timer
		Social	Competition	Point, badge, leaderboard
		Personal	Customization	Avatar
Maher et al. (2020)	Personalization	No info	No info	No info
Missaoui & Maalel (2021)	Personalization	No info	No info	No info
Roosta et al. (2016)	Personalization	Performance	Progress	Progress bar
			Feedback	
Shabihi et al. (2016)	Personalization	Performance	Reward	Point, badge
			Progress	
			Feedback	
		Personal	Goal	
Daghestani et al. (2020)	Adaptation	Performance	Reward	External resources
			Progress	
		Ecological	Choice	
			Access	
		Social	Competition	Leaderboard
			Socialization	Forum chatting
		Personal	Goal	Navigation interface
			Challenge	
Hassan et al. (2021)	Adaptation	Performance	Reward	Point, badge
			Progress	Progress bar, level
			Feedback	

Jahuš et al. (2018)	Adaptation	Social	Competition	Leaderboard
		Personal	Challenge	
		Performance	Reward	Point
			Punishment	Point
		Ecological	Time pressure	
		Social	Competition	
		Personal	Goal	
			Challenge	Fight
		Fictional	storytelling/story	Avatar
			Narrative	
Kolpikova et al. (2019)	Adaptation	Performance	Reward	Point
			Feedback	Hint
		Ecological	Choice	
Maher et al. (2020)	Adaptation	No info	No info	No info
Missaoui and Maalel (2021)	Adaptation	No info	No info	No info
Monterrat et al. (2017)	Adaptation	Performance	Progress	Level
		Ecological	Choice	
			Access	New task
Rodríguez et al. (2022)	Adaptation	Social	Competition	Leaderboard
		Performance	Reward	Point, badge
			Progress	Level
		Ecological	Access	Mini-game, Easter egg
			Chance	Lottery, development pool
		Social	Competition	Leaderboard
			Cooperation	
			Socialization	Social network, social status

		Personal	Challenge	
Shi & Cristea (2016)	Adaptation	Performance	Feedback	Reminder system
			Progress	
		Ecological	Choice	
			Access	
			Chance	
		Social	Competition	
			Socialization	
		Personal	Goal	
			Challenge	
Tan & Cheah (2021)	Adaptation	Performance	Reward	Point
			Progress	Progress bar
			Feedback	Hint
Tenório et al. (2020)	Adaptation	Personal	Goal	
			Customization	
			Challenge	Mission
Xu et al. (2017)	Adaptation	No info	No info	No info
Su et al. (2016)	Recommendation	No info	No info	No info
