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Building blocks for creating enjoyable games — A Systematic Literature Review

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ABSTRACT

Designing serious games that engage lots of players is still a challenge, especially for domains that introduce complex, specialised, and tedious tasks that are difficult to represent in a game in terms of entertainment. Therefore, researchers have investigated ways to motivate players, including enjoyment. Enjoyment is tied to emotional experience and is associated with positive player reactions throughout a gameplay session. However, an inventory with concrete elements (including descriptions and empirical proofs) producing that experience is missing. While researchers have investigated enjoyment and its relationship with game design elements (GDE) previously, the efforts remain dispersed and isolated across different areas. Besides, there is no guideline describing this relationship that assists designers in their creation process. Therefore, this paper presents a systematic literature review to provide a detailed understanding of GDE, player enjoyment, and instruments for evaluation. Additionally, an analysis of two successful cases of Games With a Purpose (GWAP, a subset of serious games) for linguistics is presented to highlight the impact of the GDE and providing relationships with the GDE mentioned in this literature review. We found 33 GDE, from which 28 positively affect player enjoyment, and they can be used as building blocks to design enjoyable GWAP (or other serious games). Further, we create a list of instruments that provide an ample understanding of the constructs of player enjoyment, namely enjoyment, immersion, flow, positive affect, and presence. The listed instruments can give researchers higher confidence as they will allow replication and comparison of studies. These two components are critical in the process of design and evaluation of games. Furthermore, the GWAP analysis shows that effectively the GDE are used in GWAP to enhance interaction and player enjoyment. Finally, conclusions and practical suggestions for future work are given.

1. Introduction

Nowadays, games are almost everywhere, going from entertainment to serious games. While the primary purpose of entertainment games is to provide pleasure and delight within leisure activities, serious games have different goals depending on the area to which they are applied. Examples include education using games to improve learning, health to improve people's physical and mental condition, biology to process images of protein structures, psychology to study human behaviour, linguistics to study language empirically by creating corpora of languages, among many others. Regardless of the purpose, serious games generally strive to engage players. Due to their nature, the design challenge is to find elements to engage players even when the primary function of the game is not to entertain. Unfortunately, despite the efforts to face this challenge, the knowledge remains dispersed through different research areas and under different levels of abstraction, namely motivational constructs and game design elements (GDE). While the motivational constructs constitute the abstract aspects that we can measure through survey questions (Lavrakas, 2013), such as enjoyment, flow, immersion, positive affect, presence, and satisfaction, the GDE represent more tangible or visible elements that we can use to design a game, to wit leaderboards, levels, rewards, goals, among others. For the former, findings suggest that the key motivator for players (Mekler et al., 2014) and the key determinant of engagement

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(Boyle et al., 2012) is enjoyment. Therefore, based on the enjoyment construct, researchers have assessed different GDE to demonstrate their influence on player enjoyment. However, no research synthesis provides designers with a complete summary of the literature on GDE: what they are, how they have been implemented, and how they have been measured concerning player enjoyment.

This study aims to provide a comprehensive summary of the state of the art that can guide designers to build their games. This analysis includes the list of GDE with positive results on enjoyment and the different instruments to assess player enjoyment as the toolbox to create and evaluate games. Furthermore, a secondary aim of this paper is to examine the practical application of GDE in a subset of serious games called Games With A Purpose (GWAP). GWAP are games that allow the generation, collection and validation of data as a side effect of people playing a game. They have been successfully used to address different problems in different domains. One of them is Natural Language Processing, in which computer systems still need large resources for training algorithms that aim to analyse and understand the human language. To create these resources, GWAP have been used for both syntactic and semantic tasks, such as the creation of a parsed French corpus (Fort et al., 2014) or referential annotation tasks, which machines are still unable to perform (Poesio et al., 2013). These studies have focused on the annotation of the corpus and their GWAP represent successful tools used to engage the crowd and complete the task. Both recruited many participants and collected thousands of annotations that no other GWAP has reported until now. Thus, as good case studies those GWAP for linguistics deserve further analysis to provide more evidence that clarifies their success from a design perspective. Analysing their GDE might thus explain what motivated players to continue playing and, in this way, indirectly identify the GDE that led to player enjoyment. Even though we focus on GWAP for linguistics because we are interested in the creation of corpora using this approach, the analysis might be helpful to those researchers interested in the design of other types of serious games.

Consequently, this paper presents two main contributions to the design and evaluation of games. First, our review provides researchers with a comprehensive overview of the 33 GDE, including the 28 that positively influences enjoyment. Additionally, the GWAP's analysis provides a better understanding of the literature and the practical application of GDE. Second, the literature review presents a list of current instruments used to evaluate player enjoyment, thus facilitating the evaluation of future games. Further, as our review provide studies showing each game design element's contributions to the associated enjoyment constructs, they can be used in future work to create design heuristics, frameworks or models that include GDE and the instruments to evaluate player enjoyment.

2. Related work

Enjoyment represents the principal motivation for players to engage with games (Sweetser and Wyeth, 2005; Mekler et al., 2014; Schaffer and Fang, 2019). Although the term is widely used in the literature, it is also used interchangeably with "engagement", leading to confusion in its use and definition. While enjoyment refers to the positive experience experienced by the players during the gameplay (Caroux et al., 2015), engagement results from that positive experience (Boyle et al., 2012). Therefore, as researchers state that enjoyment is key to explain engagement, many of them have associated enjoyment with motivational theories, such as Flow Theory (FT) and the Self-Determination Theory (SDT). FT proposes that the state of Flow involves an intense level of attention that people experience while performing an intrinsically motivated activity. Moreover, to lead to enjoyment, it requires a balance between the challenge and the skills of the player (Csíkszentmihályi, 1996). Meanwhile, SDT considers that satisfying human needs for competence (i.e. the sense of having the skills to accomplish what one is doing), relatedness (i.e. the social connection with others), and autonomy (i.e. feeling in control of the decisions one makes) also leads to enjoyment (Ryan and Deci, 2000). In this regard, Ryan et al. (2006) proposes an extended model with two more human needs to assess enjoyment in games: presence (i.e. feeling like you are part of the game) and intuitive control (i.e. ease to master the game).

Additionally, researchers have formulated several models to identify the motivations of different kind of players. Bartle proposes four types of roles or playing styles: Achievers, Explorers, Socialisers, and Killers (Bartle, 1996). Achievers' primary goal is to collect points, complete challenges and rise in levels. Explorers enjoy looking for adventure and discover how the game works. Socialisers are interested in people, so they play the game to interact with others. Killers tend to attack other players to feel fulfilled. Nacke et al. (2014) presents seven different archetypes of players in their BrainHex model: Achievers, Conquerors, Daredevils, Masterminds, Seekers, Socialisers, and Survivors. Achievers are motivated by goals and completion, Conquerors by fighting against demanding players, Daredevils by risk and excitement, Masterminds by solving puzzles and planning strategies, Seekers by exploring the whole game, Socialisers by interacting with other people, and Survivors by scary experiences in games. Likewise, the Big-

Five Personality Traits describe the five main dimensions of personality, which include openness, conscientiousness, extraversion, agreeableness, and neuroticism/emotional stability (John and Srivastava, 1999). Openness is defined as the tendency to generate new ideas and follow different values. Conscientiousness involves planning and organising tasks. Extraversion entails looking for new opportunities. Agreeableness demands mutual help, help others and help in return. Finally, neuroticism/emotional stability concerns the degree to manage fear, sadness, and stress. The above models try to clarify how the game affects the different groups of players, including how players perceive enjoyment. However, for games used in crowdsourcing, where all types of players might participate, it is challenging to satisfy every possible player. Therefore, to provide a more general approach to create enjoyment for most players, we need to understand the links between the GDE and their effects on player enjoyment.

2.1. Previous reviews on player enjoyment

A body of literature is dedicated to assessing and mapping research efforts to summarise the insights about player enjoyment (Caroux et al., 2015; Novak, 2015; Bontchev, 2016; Alghamdi and Holland, 2017; Reis et al., 2019; Schaffer and Fang, 2019). However, they tend to be limited to a specific feature. For example, Bontchev focuses his analysis on affect-based game adaptation (Bontchev, 2016). His work provides a review on adaptation models, mechanisms and practices used in affective video games, including ways of their application, assessment and experimental validation. Likewise, Reis et al. (2019) presents a summary of game adaptation approaches and potential areas to enhance the player engagement with video games. Novak conducts a literature review for instructional and motivational/affective benefits of using a storyline (Novak, 2015). He did not obtain conclusive results. Therefore, he recommends further studies to examine the effects of using story-based or non-story based approaches. Alghamdi and Holland (2017) focus their meta-level review of the literature on finding factors that improve learning performance. Although they did not focus on enjoyment, they discuss some factors, such as motivational gaming features, social interaction (collaboration), immersive gaming environments, enjoyment elements, and some gamification elements that help to improve learning outcomes. Caroux et al. (2015) provide a systematic review of current concepts of player-video game interactions. They conclude with a definition of player-video game interactions, its influence on engagement and enjoyment, and some practical considerations. Their definition indicates that the technical aspects of video games, namely input/output information, content, and multiplayer mode are the factors that influence the player's enjoyment. Within those technical aspects, content presents particular elements, such as challenge, difficulty, and narrative that represent more specific GDE.

Finally, Schaffer and Fang present a card sorting study to find the sources of enjoyment, and later they conduct a literature review (Schaffer and Fang, 2017, 2019). The authors claim that those studies are a starting point to understand how to design interactive systems. Nevertheless, they also raise the necessity of qualitative research to identify factors leading to the enjoyment and quantitative research to understand the relationship between these factors and their effect on enjoyment. Although their work is closer to our current research aims, they do not identify specific GDE (e.g. levels, leaderboards, rewards, etc.), but abstract over them by underlining the importance of factors such as friendship, cooperation, competition, creation, and many more. In that regard, this paper offers more practical guidance by including a sufficiently detailed review of empirical research, which presents the various GDE that enhance the player's enjoyment.

2.2. Situating game design elements and their categorisation

Researchers have categorised GDE under different levels of abstraction. A first category of research presents specific GDE that help designers to build games. For example, in Gamification, the elements used are called motivational affordances and represent the specific game-like elements implemented in non-game contexts. Hamari et al. (2014)'s literature review categorises 10 motivational affordances, to wit points, leaderboards, achievements, badges, levels, story/theme, clear goals, feedback, rewards, progress, and challenge. Similarly, in Human-Computer Interaction (HCI), the GDE are called game interface design patterns which are "common, successful interaction design components and design solutions for a known problem in a context, including prototypical implementations", such as badges, leaderboards, and levels (Deterding et al., 2011). Others categorise the elements under more abstract aspects such as Strategic resource management, Puzzle, Artistic movement, Sports and cards, among others (Tondello et al., 2017). Furthermore, researchers have presented categories using player traits, to wit Aesthetic Orientation, Narrative Orientation, Goal Orientation, Social Orientation, and Challenge Orientation (Tondello et al., 2019). However, this literature review focuses on the more tangible GDE (e.g. leaderboards, badges, levels, etc) that have been tested and they present evidence to contribute to the player enjoyment. By doing this, we hope to help researchers in finding

specific elements that they can use to design their games. Additionally, given that researchers use different names to refer to the elements (e.g. Gamification: affordances, HCI: game interface design patterns), we embrace the term "game design element" to refer to these specific elements and distinguish the intrinsic nature of these elements which is elements aimed to design games.

As can be seen, previous works have focused on more abstract terms to understand how players perceive enjoyment. On another level, some studies have tried to identify individual GDE and have provided summaries on its implementation. However, they have not provided a comprehensive survey of all possible GDE that impact player enjoyment. As a result, this review attempts to provide designers with the building blocks to begin their designs of enjoyable (serious) games by presenting a set of GDE, their evaluations, and player enjoyment outcomes to set precedents on linking GDE and their ability to enhance player enjoyment.

3. Method

A systematic literature review was conducted to discover the GDE that influence enjoyment. The search method was configured to target only empirical articles that evaluate the enjoyment of specific GDE. All authors agreed upon the search, screening and selection criteria. However, the first author of the present article did the review process by following the approach of Caroux et al. (2015), in which one researcher applies the classification strategy for the articles rather than multiple researchers. In the latter case, multiple researchers would subjectively rate the papers result leading them to search for an agreement. Therefore, in the presented study, the search criteria were formulated to objectively guide the person who performs the classification. While the papers and the encountered design elements were classified, the instruments used to evaluate enjoyment were also collected. Those instruments showed us the different motivational theories behind the evaluation of the GDE. Therefore, we used them as a sub-classification for the GDE within the article. Figure 1 and the subsequent paragraphs describe the steps we followed when performing this systematic literature review to select the relevant papers, including source selection, search procedure, screening, and inclusion criteria, as explained in the following sections.

3.1. Source selection

Since relevant papers are disseminated across several scientific sources and research domains, we decided to include the next publication databases: The ACM Guide to Computing Literature (ACM), IEEE Xplore digital library (IX), Springer Link (SL), ScienceDirect (SD), and Scopus (SC). The principal reason to select them is that all of them include a wide range of conferences, proceedings, transactions, and journals related to human factors and computer games. Further, for our search, we specified a time frame ranging from 2015 to June 2021 to narrow the search and include only the most recent contributions. Another reason for using this particular time frame for the review study is that 2015 presents the highest number of publications and the time frame shows more than 65% of the total of papers.

3.2. Search procedure

Our search included the terms "player enjoyment" combined with "games with a purpose" OR "serious games" OR "gamification" to narrow the search down and thus to obtain the GDE that researchers have used in their designs to enhance enjoyment. We decided to use the combined term "player enjoyment" because we found researchers mention it when they want to discover player motivations, stimulate the players' response towards the games or when they try to assess the enjoyment of players. Although we could have used the more general term "enjoyment", we discovered that occasionally the term was only used to mention that enjoyment is a fundamental element for games with no more explanations or studies within the paper. We found a total of 557 articles (ACM=59, IX=12, SL=72, SD=25, SC=389). Our final count of papers is 515 after removing 42 duplicates.

3.3. Screening criteria

As shown in Figure 1, the criteria defined to narrow the entries down include: (1) papers written in English, (2) the abstract mentions design game elements that influence enjoyment or the abstract refers to instruments to evaluate enjoyment. In criterion (2), the review requires both types of articles to collect GDE that lead to enjoyment and the instruments to assess it. Whenever the abstract is ambiguous, the introduction, results and conclusions have been screened to find out if the paper includes GDE or instruments to evaluate enjoyment. A total of 184 articles met these screening criteria.

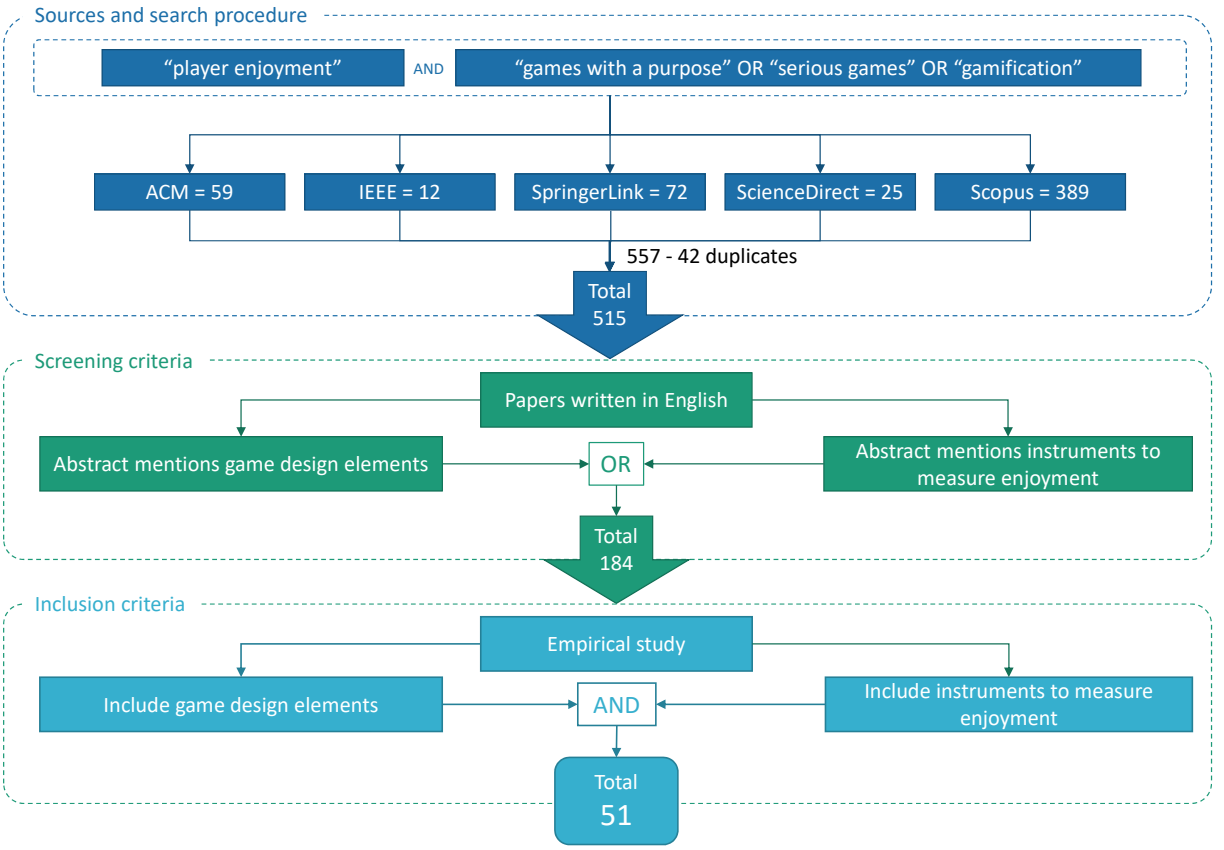

Figure 1: Systematic paper selection process including sources, search procedure, screening and inclusion criteria.

3.4. Inclusion criteria

The inclusion criteria used to select the final set of papers include: (1) the article presents an empirical study, (2) the study identifies GDE and contains instruments to evaluate enjoyment. We discarded papers that analyse player enjoyment from a theoretical perspective, papers evaluating the game but not a specific game design element, and articles identified as systematic reviews. We emphasise that the included papers mention the GDE because our final aim is to guide researchers and practitioners in their game design challenges, for which they can start from the identified valuable design elements. Extended abstracts were only included if their length is five pages or more, so thorough description of their findings can be expected. In addition, from the excluded systematic literature review papers, we mention those that talk about GDE in the related work. A total of 51 publications met the inclusion criteria, as shown in Table 1.

4. Results

The analysis of the 51 papers showed different perspectives to determine how the game elements influence player enjoyment as well as the instruments used to evaluate it. In this section, we discuss the results according to three topics: research field, instruments to measure player enjoyment, and GDE.

4.1. Research field

Several research fields have investigated player enjoyment to encourage people to use their games. These fields include Health, Education, Marketing, Psychology, among others. We classified the articles by extracting the main context. For example, some papers implement Gamification to engage patients in physical rehabilitation applications or encourage students to learn maths. Therefore, we classified those as Gamification papers. Serious games (n=14),

Table 1
Articles included in the systematic literature review after applying screening and inclusion criteria.

No.	Reference	No.	Reference
A1	Wang et al. (2015)	A27	Robb et al. (2017)
A2	Goh et al. (2015a)	A28	Kasapakis and Gavalas (2017)
A3	Mildner et al. (2015)	A29	Teruel et al. (2018)
A4	Allison et al. (2015)	A30	Alves et al. (2018)
A5	Birk et al. (2015a)	A31	Johnson et al. (2018)
A6	Nagle et al. (2015)	A32	Ruehrlinger et al. (2018)
A7	Goh et al. (2015b)	A33	Sarkar and Cooper (2018)
A8	Sun et al. (2015)	A34	Xi et al. (2018)
A9	Siemens et al. (2015)	A35	Vella et al. (2018)
A10	Bowey et al. (2015)	A36	Gray et al. (2019)
A11	Prestopnik and Tang (2015)	A37	Morschheuser et al. (2019)
A12	Iacovides et al. (2015)	A38	Haller et al. (2019)
A13	Turkay and Adinolf (2015)	A39	Xi et al. (2019)
A14	Guo et al. (2016)	A40	Cuthbert et al. (2019)
A15	Birk et al. (2016)	A41	Barak Ventura et al. (2019)
A16	Smeddinck et al. (2016)	A42	Li et al. (2019)
A17	Nagle et al. (2016a)	A43	Darzi and Novak (2019)
A18	Forde et al. (2016)	A44	Navarro et al. (2020)
A19	Bopp et al. (2016)	A45	Nebel et al. (2020)
A20	Jia et al. (2016)	A46	Goršič et al. (2020)
A21	Yildirim (2016)	A47	Schneider et al. (2020)
A22	Nagle et al. (2016b)	A48	Ntokos (2020)
A23	Petralito et al. (2017)	A49	Martin and Magerko (2020)
A24	Berglund et al. (2017)	A50	Bui et al. (2020)
A25	Martin-Niedecken and Götz (2017)	A51	Darzi et al. (2021)
A26	Goh et al. (2017)		

Games User Research (GUR, n=12) and Gamification (n=11) were the most frequently mentioned areas. Other areas focused on are Motion-based games (n=5), Crowdsourcing (n=3), Human-Computation Games (HCG, n=3), and Learning games (n=3), as shown in Table 2. This information confirms that games are used in a wide range of application domains that show an interest in investigating methods to motivate and engage the players.

Table 2
Research fields

No.	Field	Quantity
1	Serious games	14
2	Games User Research (GUR)	12
3	Gamification	11
4	Motion-based games (e.g. Exergames)	5
5	Crowdsourcing	3
6	Human-Computation Games (HGC)	3
7	Learning games	3
	Total	**51**

4.2. Instruments to measure player enjoyment

We found 23 unique instruments used to evaluate enjoyment, which we classified into two groups: instruments to measure enjoyment (n=16) and instruments to measure other factors that influence enjoyment (n=6). Additionally, physiological measures (n=1) were used to both evaluate and influence player enjoyment. Table 3 shows the complete list indicating the number of articles that used the instruments and the group where they belong in our classification.

As can be seen in the table, the total number of instruments is higher than the number of papers. The reason for this is that some papers describe more than one instrument, as occasionally, multiple instruments are used in an experiment.

Table 3
Measurement instruments classified by effects on player enjoyment (E = 16) and other factors that influence player enjoyment (I = 6). Physiological measures (E/I = 1) were used to evaluate and influence player enjoyment.

No.	Instrument	Quantity	Group
1	Own questionnaire	31	E
2	Intrinsic Motivation Inventory (IMI)	16	E
3	Player Experience of Need Satisfaction (PENS)	10	E
4	Game Experience Questionnaire (GEQ)	5	E
5	Perceived Enjoyment (PE)	5	E
6	Physiological measures	4	E/I
7	Positive and Negative Affect Schedule (PANAS)	4	E
8	Ten-Item Personality Inventory (TIPI)	3	I
9	Scales by Oliver and Bartsch (2010)	2	E
10	Achievement Emotions Questionnaire (AEQ)	1	E
11	Bartle Test (BT)	1	I
12	Bartsch Questionnaire (BQ)	1	E
13	Flow Experience Measure (FEM)	1	E
14	GameFlow Questionnaire (GQ)	1	E
15	Intention To Play (INT)	1	I
16	I-PANAS-SF	1	E
17	IPIP Big-Five Factor Markers	1	I
18	O'Brien and Toms' Engagement Scale (2010)	1	E
19	Positive and Negative Affect Schedule-Expanded (PANAS-X)	1	E
20	Rosenberg Self-Esteem (RSE) Scale	1	I
21	Schmierbach (2014)	1	E
22	Self-Assessment Manikin (SAM) Scale	1	I
23	The CEGE Questionnaire (CEGEQ)	1	E
		Total = 94	

4.2.1. Instruments to measure the construct of enjoyment

Enjoyment was assessed by instruments that measure constructs related to enjoyment, such as immersion, flow, and positive affect. We found standardised questionnaires as well as their adaptations. The standardised questionnaires include the Intrinsic Motivation Inventory (IMI, n=16) (McAuley et al., 1989), the Player Experience of Need Satisfaction (PENS, n=10) (Ryan et al., 2006), the Game Experience Questionnaire (GEQ, n=5) (Poels et al., 2006), Perceived Enjoyment (PE, n=5) and the Positive and Negative Affect Schedule (PANAS, n=4) (Watson et al., 1988). Meanwhile, nine instruments were used only once within the papers reviewed: (1) Achievement Emotions Questionnaire (AEQ), (2) Bartsch Questionnaire (BQ), (3) Flow Experience Measure (FEM), (4) GameFlow Questionnaire (GQ), (5) I-PANAS-SF, (6) O'Brien and Toms' Engagement Scale (2010), (7) Positive and Negative Affect Schedule-Expanded (PANAS-X), (8) Schmierbach (2014), and (9) The CEGE Questionnaire (CEGEQ). We also encounter physiological measures (n=2), and the remaining consisted of self-developed surveys or questionnaires (n=31).

Within this group, we can also sub-classify the instruments based on the theories that lead to enjoyment. In that regard, we find two main theories, namely the Self-Determination Theory (SDT) and Flow Theory (FT). Within SDT, two instruments, PENS (Ryan et al., 2006) and IMI (McAuley et al., 1989), have been designed to measure need satisfaction. PENS was developed as an instrument to assess the psychological needs because it is argued that it can predict game enjoyment and future gameplay. PENS includes the sub-scales of SDT plus two more: Intuitive Control and Presence. Meanwhile, IMI can measure needs satisfaction and assess dimensions of the intrinsic motivation related to a game, namely interest-enjoyment, pressure-tension, competence, and effort-importance.

Regarding the flow construct, we find in the systematic literature review some instruments to measure it. Between them, the GEQ (Poels et al., 2006) which was developed to measure GameFlow and immersion. It consists of a couple of questions for each of the eight dimensions: competence, sensory immersion, imaginative immersion, flow, tension,

challenge, negative affect and positive affect.

4.2.2. Instruments to measure other factors that influence enjoyment

These questionnaires measure personality or other determinants that influence the levels of enjoyment. We found 6 questionnaires, to wit (1) Ten-Item Personality Inventory (TIPI), (2) Bartle Test (BT), (3) Intention To Play (INT), (4) IPIP Big-Five Factor Markers, (5) Rosenberg Self-Esteem (RSE) Scale, and (6) Self-Assessment Manikin (SAM) Scale. Further, we found a couple of studies that used physiological measures (n=2) to adapt the games and induce higher levels of enjoyment. All of them were used once within the reviewed papers, except for TIPI (n=3).

Researchers used some of these instruments to analyse how traits that reflect personality regulate the levels of enjoyment. For example, TIPI and the BFI analyse how the Big-Five Personality Traits (i.e. openness, conscientiousness, extraversion, agreeableness, and emotional stability) influence those levels. Likewise, the RSE scale was used to assess self-esteem and researchers found that this personality trait also predicts enjoyment through higher values in autonomy, presence and intuitive control. In comparison, other instruments help to categorise the players and understand their relation to enjoyment. For example, the BT classifies players in four categories, namely Killers, Socialisers, Achievers, and Explorers.

4.3. Game design elements

This systematic literature review identified 33 GDE that demonstrated their ability to influence player enjoyment. Table 4 shows the number of articles studying each element and the number of studies with impact on enjoyment in which rewards, adaptation, customisation, and leaderboards were the most assessed. Figures 2 and 3 classify these GDE following the motivational theory with which they can be related. These figures also explicit the relationship that exists between the GDE, the instruments and the constructs that are used to evaluate player enjoyment. We see the SDT and the FT again as the main motivational theories. SDT evaluates player enjoyment through many means. First, by using different instruments to measure GDE' impact on any of the five needs (i.e. autonomy, competence, relatedness, presence and intuitive control). Then, through the Big-Five Personality Traits that help to influence the levels of need satisfaction, getting also significant results over enjoyment. Likewise, FT exhibits positive results for enjoyment by evaluating other GDE with instruments based on this theory. Further, Figures 2 and 3 also show other models and instruments used to assess many other GDE. In what follows, we describe the GDE categorised by motivational model, how they have been evaluated and their results for enjoyment. Lastly, we mention the GDE with no impact on enjoyment.

4.3.1. Enjoyment based on SDT

Researchers claim that satisfying any of the five needs is a predictor of higher enjoyment (Birk et al., 2015b). We found 22 studies that include 11 GDE that confirm these claims. Rewards, adaptation, leaderboards, and customisation, among others are able to increase enjoyment through need satisfaction.

Three studies find positive effects of **customisation** on enjoyment. Cuthbert et al. (2019) use three experimental conditions to show that customisation can increase enjoyment in digital environments: (1) no customisation options, (2) aesthetic customisation, e.g. colours, avatar type, and (3) functional customisation, e.g. difficulty. Although these researchers did not find significant differences between the conditions, they observe that the groups with customisation conditions experience higher levels of autonomy compared with the no customisation condition. Ruehrlinger et al. (2018) experiment with customisation to determine its effects on enjoyment, competence and relatedness in an intergenerational game. Their experiment consists in the collaboration of young and old players to build a spaceship and then to play the game. They use three conditions to build the spaceship: (1) using tangible objects, (2) using touchscreens, and (3) removing the customisation phase. They find that conditions 1 and 2 where young and old collaborate to customise the spaceship exhibits higher enjoyment and social relatedness ratings compared to the third condition with no customisation. Likewise, Smeddinck et al. (2016) study the impact of game difficulty adjustments, using three conditions: (1) embedded, (2) menu, and (3) auto. The embedded and menu conditions both allow the player to choose the level of difficulty. Their findings demonstrate an increased sense of autonomy in the embedded condition. Consequently, they conclude that presenting a simple menu is enough to customise levels of difficulty.

Two papers show the impact of **competition** on enjoyment. Goršič et al. (2020) experiment with a two-player competitive Pong game for arm rehabilitation. Four conditions were evaluated: (1) single-player, (2) single-player with a partner, (3) human-human competition, and (4) disguised researcher. In (1) and (2), the opponent is the computer, but in (2), a person sits with the player without playing the game. In (3), the opponent is another person, and in (4),

Table 4
Game design elements classified by main motivational theories and the number of articles studying their impact on player enjoyment.

No.	Game design elements	SDT	FT	SDT/FT	PE	Other	Total	No impact
1	Rewards	3	1		1	4	9	2
2	Adaptation	2	2			4	8	
3	Leaderboards	2				5	7	
4	Customisation	5	1				6	2
5	Challenges		2			3	5	
6	Competition	2			1	1	4	1
7	Feedback	3				1	4	4
8	Avatar	1				2	3	1
9	Goals		1			2	3	1
10	Interfaces		1			2	3	
11	Negative experiences			1		2	3	
12	Points			1		2	3	1
13	Aesthetics		1			1	2	
14	Cooperation				1	1	2	
15	Mechanics			2			2	
16	Presentation modes					2	2	
17	Progress	1				1	2	
18	Storyline		1			1	2	
19	Affective embodied agents (EAs)				1		1	
20	Badges					1	1	
21	Choices					1	1	
22	Game awareness					1	1	
23	GPS-guided activities	1					1	
24	Levels					1	1	
25	Role-playing game					1	1	
26	Simplified simulation	1					1	
27	Social community					1	1	
28	Sound	1					1	1
29	Usability		1				1	
30	User-generated content					1	1	
31	Virtual pets				1		1	
32	Virtual rooms				1		1	
33	Virtual spectators					1	1	
	Total	22	12	4	6	42	85	13

the opponent is a disguised researcher simulating a human-like opponent. Their results show differences between conditions for interest/enjoyment, effort/importance, and perceived competence. Therefore, for competitive games, human competitors or computer-controlled opponents that are more human-like provide higher enjoyment values. Likewise, Navarro et al. (2020) investigate non-competitive and competitive groups in an intervention designed to address attention deficit for patients experiencing a stroke. The results demonstrate that the competitive peers show significantly greater improvements in all cognitive abilities and report greater enjoyment than their non-competitive peers.

Birk et al. (2015a) implement a **leaderboard** manipulation to control the effects of their experiment and to create the feeling that the players are in an actual game. The leaderboard displays positive (1st place), neutral (5th to 8th place) or negative (11th place) places. One of the aims of this study consists in measuring the effects of self-esteem in enjoyment. Even though they do not provide evidence of the leaderboard effect, their results show that higher self-esteem predicts higher enjoyment as well as an increase in autonomy, presence, and intuitive control. However, the question remains "is player enjoyment influenced by the implementation of the leaderboard as a game design element or is it rather due to the player's self-esteem? A similar experiment has been performed by Bowey et al. (2015), which included three conditions: (1) success, (2) neutral, and (3) failure. For each condition, players were assigned randomly

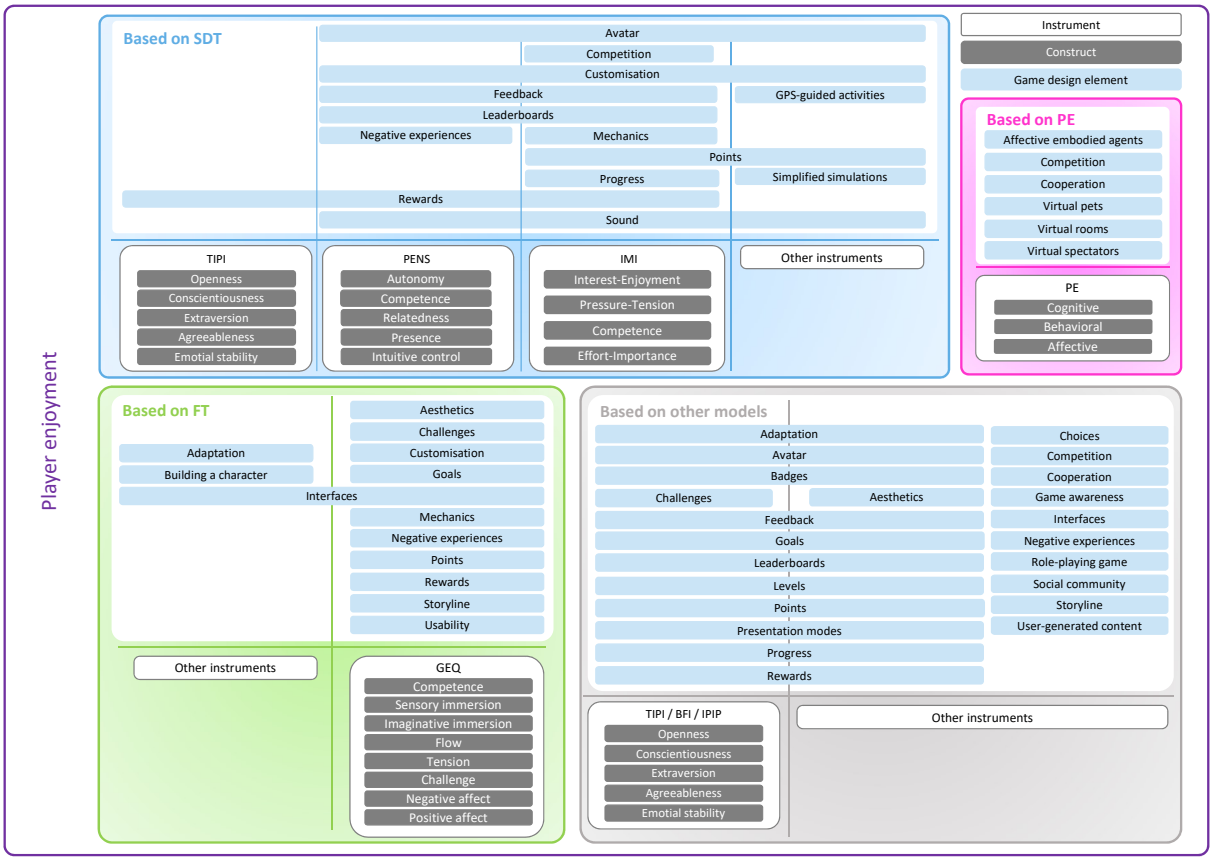

Figure 2: Theories, instruments, constructs and GDE that enhance player enjoyment. Rounded boxes with blue, green, pink, and grey background group theories, such as Self-Determination Theory (SDT), Flow Theory (FT), Perceived Enjoyment (PE), and others models.

a position on the leaderboard (between 1-3, 8-12, 14-20, respectively) to manipulate a sense of success or failure. Their results indicate that the position showing a sense of success led to greater perceived competence, autonomy, presence, enjoyment, and positive affect than the failure condition.

Johnson et al. (2018) experiment with levels of **rewards**: low, medium and high. They find a significant effect on higher presence-immersion and enjoyment for the high-level condition compared with the low-level. Therefore, they infer that more rewards lead to more presence and enjoyment. Goh et al. (2017) investigate how virtual reward systems evoke intrinsic motivation and perceived enjoyment in the context of crowdsourcing games. Three versions of their game were developed to evaluate three conditions. The Track version offered a points-based reward system for actions such as the contribution of content. The Badge version gave different badges for collection, while the Share version served as a control as it did not have any virtual reward system. Their results indicate that participants perceived higher autonomy in the Badge version and higher competence in the Badge and Track versions. In prior preliminary work done by Goh et al. (2015a), points and badges were shown to be perceived as being more enjoyable when compared against no rewards. However, both reward systems were perceived equally when assessed only with PE. Additionally, that study does not consider the influence on intrinsic motivation, unlike their their updated experiment in 2017. Further, Berglund et al. (2017) study the impact of the reactive mechanic and strategic mechanic. In this study, the reactive mechanic consists in rewarding the player with more points for quicker collection of bugs, while the strategic mechanic focuses on rewarding strategic collection decisions, such as those based on colour (2 bugs of the same colour provide double points, 3 triple points and so on). Participants played both game mechanics. Researchers did not find significant differences between the mechanics, but both are associated with higher competence levels when the game is played a second time. They conclude that this effect is because the players feel more confident playing the game the second

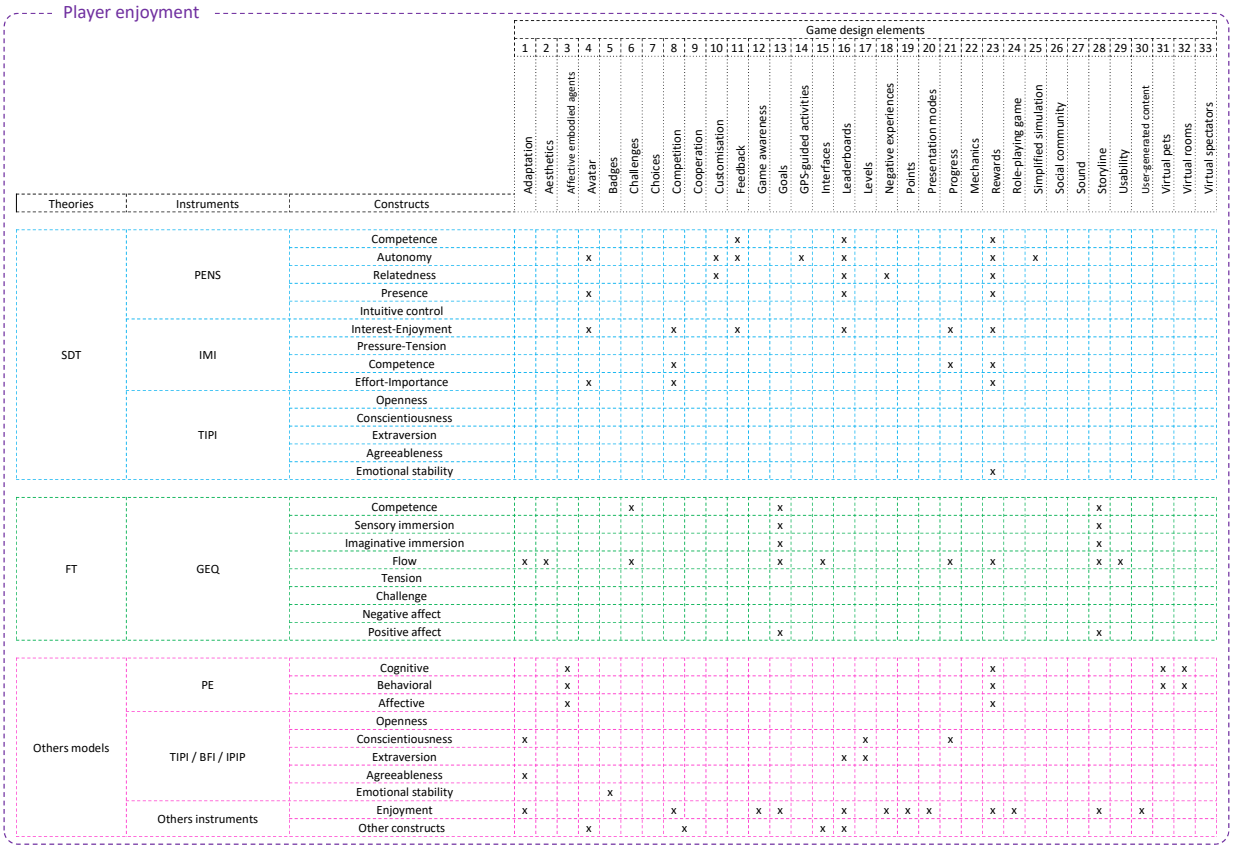

Figure 3: Matrix showing the theories, instruments, constructs, and GDE. "x" indicates the constructs that reflect positive values on enjoyment for each game design element. Colours connect the theories with Figure 2.

time, and they put more effort to improve their game.

Gray et al. (2019) explore the design of an active smartphone cognitive training game. The game includes multiple GDE intended to provide competence (e.g. incremental challenge increases in response to user progress, the inclusion of multiple tools to support the user, performance feedback, the leaderboard and trophy systems), relatedness (e.g. cooperation between participants, and opportunities to socialize by comparing their achievements) and autonomy (e.g. options to cooperate or compete with other players). Those elements were assessed using semi-structured interviews after the intervention. Their findings report that extrinsic motivators such as trophies (rewards) and leaderboards facilitate a feeling of competence and relatedness. Further, they help to create competence between participants by comparing their trophy cabinets and leaderboard scores.

Building a character is a more humanised approach to give **progress** feedback to the player. Therefore, Siemens et al. (2015) hypothesise that building a character is more enjoyable than presenting a status bar. To test it, they use instruments from SDT and FT in which they show higher levels of enjoyment for the SDT instruments and higher values of perceived competence and flow for FT. Li et al. (2019) present another form to give **feedback**, namely diegetic and non-diegetic feedback. Diegetic feedback involves the elements that are a part of the game world, for example, the progress map. In contrast, non-diegetic feedback is not visible inside the spatial game space, for example, a vertical progress bar. Their findings show that players perceived more competence and autonomy with the progress map and reported significantly stronger feelings of enjoyment.

GPS-guided activities involve the use of GPS to navigate outdoors, and the **simplified simulation** consists in a computer-based simulation game with less cognitive complexity (compared with a PC simulation) to increase its playability. These elements are used to create a educational location-based game and evaluate the enjoyment provided by the simplified simulation. Their results show for both elements higher levels of enjoyment and higher levels of need

satisfaction for autonomy (Schneider et al., 2020).

Kasapakis and Gavalas (2017) investigate the impact of **user-generated content** on player experience. Although they do not explicitly intend to evaluate SDT, aspects associated with relatedness are included as they conclude that the content created by other players and incorporated into the game give the creators and players a sense of participatory involvement and also increases enjoyment.

Birk et al. (2016) propose that player identification with a game **avatar** will increase the intrinsic motivation. Their experiment involves three types of identification (similar, embodied, wishful) as individual continuous predictors that players can customise. Their results show that greater identification increases experienced autonomy, immersion, invested effort, enjoyment, and positive affect.

Petralito et al. (2017) studied the impact of **negative experiences** on enjoyment. They asked participants to report an outstanding positive or negative experience in their recent play session of one popular game. Enjoyment was evaluated very high for positive experiences and negative experiences. Therefore, the authors suggest that even negative experiences can be perceived as enjoyable when players realise that they are learning and can achieve an increased experience.

Researchers have also investigated how to influence enjoyment by moderating the levels of satisfaction using the Big-Five Personality Traits and the BrainHex model. Based on these two models, researchers have been able to identify key relations between personality and GDE. Nagle et al. (2016a,b) study the relationship between the Big-Five Personality Traits and enjoyment in two experiments based on **rewards** and difficulty **adaptation**. In the first study, they apply three conditions for the rewards: (1) performance-contingent rewards, (2) task-contingent rewards, and (3) no rewards. Their findings confirm that rewards can enhance intrinsic motivation by choosing an appropriate reward contingency. They find that interest/enjoyment is higher in the performance condition than in the task condition. Further, relating the award to personality results in significantly higher interest/enjoyment and perceived competence than only basing it on performance (Nagle et al., 2016a). In the second study, they use four conditions for difficulty adaptation: (1) Dynamic Difficulty Adjustment (DDA), (2) PLATEAU (difficulty linearly increases with a plateau after a point), (3) REVERSE (maximum difficulty at the beginning and decreases over time), and (4) REST (intervals of low difficulty). While DDA intends to adapt the difficulty based on player skills, PLATEAU, REVERSE, and REST follow a specific curve of difficulty. Their results confirm their hypothesis in which the PLATEAU condition provides a higher level of conscientiousness and agreeableness and therefore, more enjoyment (Nagle et al., 2016b).

4.3.2. Enjoyment based on FT

On the subject of flow, twelve studies and ten GDE were found, among which storyline, adaptation, aesthetics, usability, interfaces, rewards, and challenges. Prestopnik and Tang (2015) discover that a game based on a **storyline** result in a significantly more compelling player experience compared with a points-based and non-fantasy game. Players feel more competent and experience higher levels of flow, immersion, and positive affect.

Alves et al. (2018) find that **adaptation** based on performance show higher levels of flow compared to adaptation based on the mental state (keeping the player in a state of flow) which was their initial hypothesis. Similarly, Martin-Niedecken and Götz (2017) conduct a study about adaptation with two conditions. The adaptive condition consists in gradually increasing the difficulty and complexity of the game. Meanwhile, the non-adaptive one keeps the same difficulty and complexity during the whole level. They find higher values for GameFlow, dual flow, motivation, and enjoyment in the adapted condition.

Time pressure as a **challenge** in games has been investigated by Yildirim (2016). He conducted a study to examine the relationship between time pressure, autonomy, and competence and how it affects intrinsic motivation, flow, engagement, performance, and enjoyment. His experiment contains two conditions in which the participants played one of two different versions of the game: without (control group) or with a time limit (experimental group). His findings do not reveal a significant difference in the dependent variables between the two conditions, except for flow. However, he analyses three new conditions at the end of the experiment: (1) out-of-time-experimental, (2) successful-experimental, (3) successful-control. In (1), the players that could not complete the task were included. In (2) and (3), only players that successfully achieved the task were included. His final analysis shows significant differences in perceived time pressure, flow, and engagement between the three conditions.

Goals is another game design element evaluated under the FT. The experiment of Martin and Magerko (2020) aims to find if particular achievement goals types are predictors of flow. To do so, four achievements goals were assessed: (1) mastery-approach, (2) mastery-avoidant, (3) performance-approach, and (4) performance-avoidant. In (1), the goal is attaining mastery of a task. In (2), the aim is to avoid self-referential task incompetence. In (3), the goal is performing

better than others, and in (4), avoid performing worse than others. Their results show that mastery-approach is the only type that shows higher values for positive affect, competence, sensory immersion, imaginative immersion, and flow.

Bui et al. (2020) find that better **aesthetics**, **usability**, clarity in the user **interfaces**, and **rewards** (e.g. in-game currency, in-game items) leads to a positive gaming experience and **challenges** make it more demanding.

4.3.3. Enjoyment based on other psychological models

Perceived Enjoyment (PE) (Nabi and Krcmar, 2004) is another model that has helped researchers to evaluate enjoyment. It is defined as the extent to which performing an activity is considered enjoyable in its own right. PE suggests that enjoyment is a complex construct that can be captured through three dimensions, namely affective (emotional experiences), cognitive (evaluative judgements related to gameplay), and behavioural ones (level of involvement or immersion during gameplay). In this regard, six GDE have been assessed using instruments based on this model. Goh et al. (2015b) conduct an experiment for their game which includes virtual pets, virtual rooms, and player profiles. Virtual pets represent units that change their aspect according to the content (food) that the player provides. Virtual rooms represent the spaces where the pets live and provide a platform for social interaction between players. The player profile is a customisable avatar that can be shown off to other players. This study shows that the use of **virtual pets** and **virtual rooms** leads to more cognitively and behaviourally enjoyable results. Similarly, Guo et al. (2016) evaluated other virtual agents called Affective Embodied Agents (EAs). These agents have been incorporated into the Digital Game-Based Learning (DGBL) system as companions or instructors. In their experiment, three versions of a role-playing game that aims to engage university students were developed. Each version corresponds to three different conditions: (1) affective-EA, (2) neutral-EA, and (3) no-EA. In condition (1), the agent includes affective feedback, facial expressions and body gestures. In (2), the agent gives feedback maintaining the same facial expression and body gesture. Meanwhile, in (3), there is no agent, and all feedback is given as text in the centre of the screen. Their results demonstrate that the affective-EA condition has a positive impact on participants' learning motivation, enjoyment, perceived usefulness and behavioural intention, compared with the neutral-EA and no-EA conditions.

Cooperation and **competition** have been assessed by Morschheuser et al. (2019) using three versions of a gamified crowdsourcing system corresponding to three conditions: (1) competitive, (2) cooperative, and (3) inter-team competitive gamification. In (1), the participant's goal is to become the "ParKing" by collecting more hexagons. In (2), the participant's goal is to contribute to enlarging the joint "ParKing realm" by conquering many hexagons in cooperation. In (3), the participant can join one of the three competing teams with the overall goal to jointly conquer and defend the largest "ParKing realm". They do not find a significant difference when comparing the motivational outcomes between the gamification conditions. However, tests in dependant variables show significant differences in the perceived enjoyment between the gamification conditions. The inter-team competitions in which cooperation and competition are combined reveals higher enjoyment levels. Additionally, it engages more crowdsourcing participants than pure competitive or pure cooperative gamification.

Jia et al. (2016) study the relation between motivational affordances (e.g. points, leaderboards, badges, levels, etc) and the Big-Five Personality Traits. They find that people with high conscientiousness perceive **progress** and **levels** to be more motivating. Meanwhile, extraversion correlates more with motivation in **leaderboards** and **levels**. They also find that people with higher levels of agreeableness prefer **challenges** because they perceive them as more enjoyable. Finally, players with lower emotional stability scores consider **rewards** and **badges** more enjoyable.

Besides perceived enjoyment and the Big-Five Personality Traits, researchers have assessed other game elements using self-developed tools, such as surveys, questionnaires, and even physiological measures. These elements include presentation modes, challenges, choices, negative experiences, leaderboards, storyline, avatars, goals, points, adaptation, game awareness, rewards, and role-playing game. Mildner et al. (2015) evaluate six scenarios combining five different components: (1) presentation (two modes to present the answers in the game), (2) challenges (limit the number of moves), (3) choices (jokers to increase the possible answers), (4) leaderboards (two lists, one for each presentation mode), and (5) adaptation (difficulty adaption based on a basic and advanced algorithm). Their results indicate that the implementation of **presentation modes** increases motivation, having choices increases learning outcomes, and **adaptation** and **leaderboards** increase both fun and learning outcomes. Meanwhile, challenges do not produce a positive effect on enjoyment. Wang et al. (2015) also evaluate multiple elements, which they call aesthetic elements, and include sensation (aesthetics), fantasy (avatar), narrative (storyline), challenge (difficulty), fellowship (social community) and submission (goals, points, leaderboards). Their results demonstrate that some of the elements increase the levels of enjoyment, specially **storyline**, **goals**, **points**, and **leaderboards**.

Allison et al. (2015) analyse the **negative experiences** in games. They hypothesise that negative experiences (dying

and the consequences of dying) are also attractive and become positive features for players. Their results show that players rate the dying feature as enjoyable because the awareness of risk produces adrenaline and the relief of not dying shifts thus to a positive outcome. They conclude that one must look beyond a binary affect-based understanding of the player's response and consider the meaning that the playing experience is creating (either positive or negative). In the same fashion, Bopp et al. (2016) conduct an experiment for emotional experiences in games. Their results corroborate that negative emotions can lead to enjoyable experiences in players.

Sun et al. (2015) assess **leaderboards** by displaying the players' scores on different positions. Their results indicate that presenting players in the second, fourth, or seventh leaderboard positions maximised enjoyment and likelihood of replay. Similarly, Gray et al. (2019) find that the leaderboards and rewards facilitate feelings of competence and relatedness.

Iacovides et al. (2015) experiment with two versions of a game to investigate the interaction with diegetic (elements that the player-character can view) and non-diegetic (elements that the player only views) **interfaces**. They do not find significant differences concerning enjoyment. However, in a second study comparing novice and expert players, they find that removing non-diegetic elements increases immersion only for expert players.

Two studies of Teruel et al. (2016, 2018) targeting **game awareness** (real-time information provided to players within the game) show that players' enjoyment increase with the right level of awareness. For example, a high level of awareness is helpful for beginners but is annoying for more experienced players. Finally, Ntokos (2020) implements a **role-playing game** to teach software engineering. He hypothesises that the gamified learning course engages the students by providing motivation and satisfaction. He obtains positive results for both factors.

Vella et al. (2018) use casual games as **rewards** to engage participants in a health app. They find that casual games are a compelling incentive to drive enjoyment for the well-being application. Xi et al. (2018, 2019) explore **visual presentation** and **rewards** and their relation with hand gestures. They find that touching a real product picture on the screen leads to greater enjoyment than touching the brand logo. Regarding the rewards, whenever the final reward is uncertain, participants who use motion gestures evaluate reward as more enjoyable than those who use surface gesture.

Darzi and Novak (2019) assess difficulty **adaptation** using physiological features in a competitive rehabilitation game. They include six conditions (two for each participant): (1) fair and slow, (2) fair and fast, and (3) two unfair conditions. They find that the fair and fast condition produces a higher difficulty level, more significant levels of enjoyment and the most positive emotional valence. Similarly, Nagle et al. (2015) experiment with dynamic difficult adaption (DDA) and the effects of regularly changing visual elements (e.g. background, foreground, and animations). They hypothesise that changing those visuals elements can also increase enjoyment. They test DDA combined with visual changes DDA-VISUAL against only DDA. Their findings suggest that participants in the DDA-VISUAL show higher values of enjoyment. However, the hypothesis is not fully accepted because the results were only significant during the second and third days of the intervention. Further, the results suggest that the enjoyment increases over the days, so changing visual elements is a simple and low-effort method to sustain enjoyment and attention in serious games.

Barak Ventura et al. (2019) explore the effect of **cooperation** in physical therapy by leveraging cooperation among users in an environmental citizen science project. Three groups were compared: (1) independent termination, (2) joint termination, and (3) the control group. In (1), participants can continue contributing to the project while their peers quit the task. In (2), participants end the task at the same time. In (3), participants can withdraw from the activity at any time. Their findings indicate that cooperation is not always positively associated with engagement, enjoyment, and motor performance. Moreover, enjoyment decreases when users are in the joint termination. Therefore, the authors suggest giving independence among users and carefully design the cooperation system.

4.3.4. Game design elements with no impact on enjoyment

Other efforts assessing GDE do not observe positive results. Jia et al. (2016) do not find a relation between enjoyment and the Big-Five Personality Traits for other elements, namely **avatar**, **goals**, **feedback** and **points**. Players evaluate avatar and points as helpful or reliable, meanwhile goals and feedback do not provide significant results in their data. Likewise, the findings of Forde et al. (2016) suggest that adding **feedback** by showing points, a score bar and information about matches and errors on an easy task do not make it more enjoyable but informative. Similarly, Haller et al. (2019)'s results show no significant effect in the use of virtual spectator feedback to increase motivation, enjoyment, and performance of users. Moreover, the presence or absence of **sound** has also no significant results on enjoyment (Robb et al., 2017). Meanwhile, **adaptation** shows contradictory results: no effect on presence/immersion but some influence in perceived autonomy. Therefore, researchers state that the differences were not significant enough

to impact the overall enjoyment, motivation and affect. Moreover, they recommend the use of customisation to choose the levels of difficulty instead of automatically adapt the difficulty (Smeddinck et al., 2016). Similarly, Darzi et al. (2021) evaluate the user experience in an exergame where DDA is configured using one of five methods: (1) manual, (2) random, (3) performance-based, (4) personality-performance-based, and (5) physiology-personality-performance-based. They do not find significant differences in enjoyment between the configurations.

Customisation is another element that has no positive effects on enjoyment. Turkay and Adinolf (2015) performed a study with participants randomly assigned to one of two groups, Customisation and No Customisation. The Customisation group can change cosmetic and functional aspects of the game while the No customisation cannot. Even when there are no statistically significant differences between the groups, they find that customisation was a factor that motivates the participant to play again. Similarly, Sarkar and Cooper (2018) present three conditions in their experiment: (1) Blind, (2) Ratings, and (3) Choice. In (1), the players are transferred to another level without showing their current rating. In (2), players are shown their rating and moved to the corresponding level. In (3), players are offered feedback and choose their next level. The Choice condition does not show improvements for enjoyment. Neither, giving **feedback** to the players of their ratings lead to higher positive values for any of the IMI measures.

Nebel et al. (2020) compare three forms of social **competition**, namely playing against a human competitive agent, playing against an artificial competitive agent, and playing against an artificial leaderboard. They do not find significant difference between the conditions for enjoyment.

5. Findings

Findings reported in the present review demonstrate a strong correlation between a range of GDE and player enjoyment. We have seen that researchers have studied this relationship in different study domains using connections with theoretical foundations and obtaining positive results through experimental studies. In this section, we will discuss the GDE that have been studied within different motivational theories and that gave rise to positive results in player enjoyment.

5.1. Connections between game design elements

While for the analyses in the previous sections, we have used the terminology that other authors used when discussing their research results, here we will try to synthesise and reorganise the various GDE (see Figure 4). For instance, rewards can be regarded as an umbrella term which comprises GDE, such as badges, levels, leaderboards, and points. In contrast, others are the effect of different configurations, such as challenges that might be the result of difficulty adaptation, customisation, or a new level in the game. Further, others can represent multiple types of elements, for instance, levels, which in turn can be a reward, represent the progress in the game or the level of difficulty that is currently being played. Additionally, in Figure 4, we arrange the GDE into layers to present the possible relationship between them. The first layer includes aesthetics, interfaces, usability, and mechanics that in a sense are the base of the design, how the game looks, the structure of game screen, the rules of the game, among other aspects. The second combines most of the elements to provide the interaction inside the game, what are the challenges, the rewards, the levels, and more. The last layer provides specific elements that can be incorporated if the design of the game requires it: for example, the game incorporates a storyline in which a virtual pet is a hero with the mission to save their master, in which case, we need to include the storyline and the virtual pet in the design. As we have seen, each game design element enhances the player enjoyment; however, as shown in Figure 4, the combination of all of them can contribute to further enjoyment. Therefore, we believe that understanding the GDE and their impact on the constructs of enjoyment is the first step to find possible relationships between them and then find a balance to stimulate enjoyment.

5.2. Implementations of individual game design elements

The primary purpose of the game design element **adaptation** within the reviewed papers consists in adjusting the level of difficulty based on performance, personality or even physiological features (mental state). Adaptation based on performance and personality demonstrates higher levels of enjoyment compared with adaptation based on mental state. Furthermore, adaptation comes in different shapes and sizes, depending on the type of game. For example, for First-Person Shooter (FPS) games, the difficulty can be adapted by changing the velocity, health and frequency in which the enemies are generated or increasing the speed and reducing the detection radius of the enemies. For physical or rehabilitation games that train motor skills, the difficulty can be controlled by changing the size of the objects that

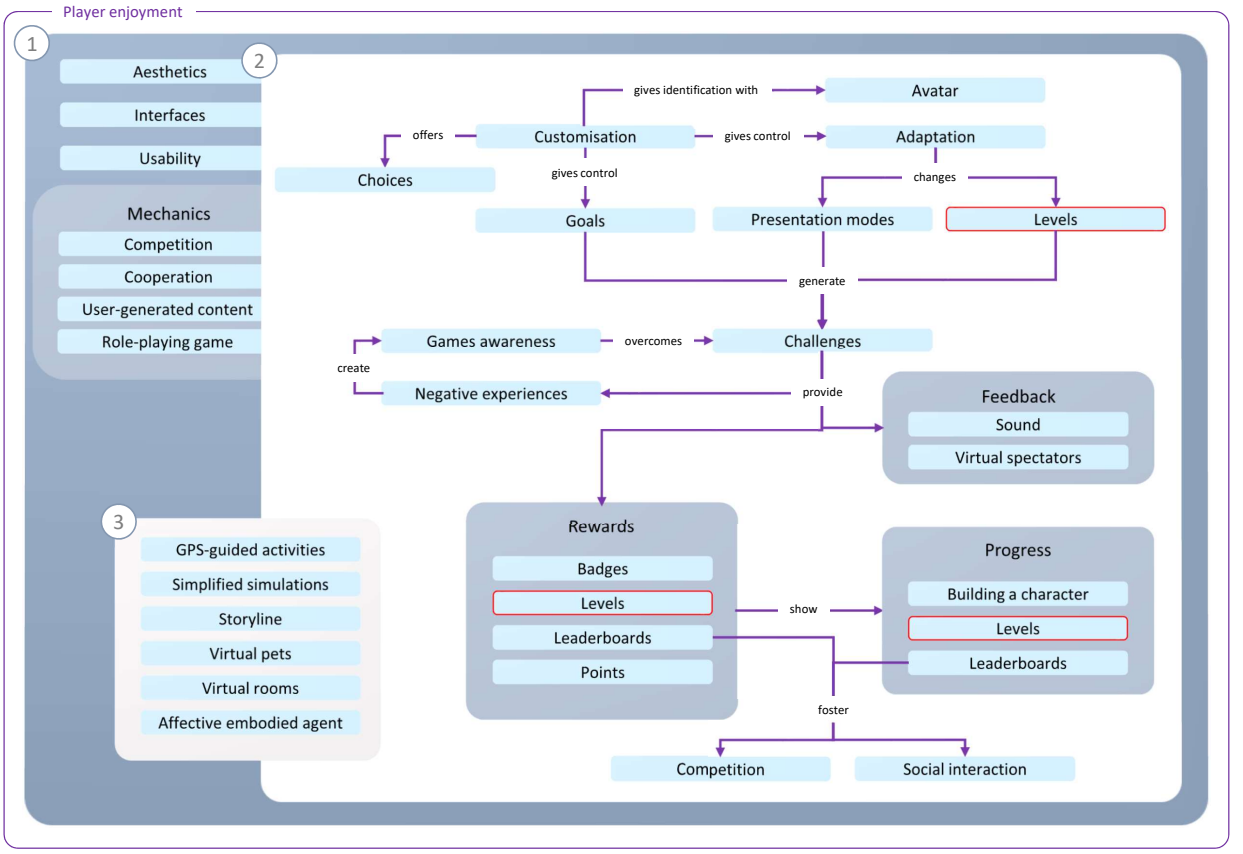

Figure 4: Connections between game design element to enhance player enjoyment. Some elements incorporate other components, while others are the effect of different configurations.

the player interacts with or by increasing the speed or frequency of the obstacles. For learning games, the difficulty adaptation can use **levels** to adjust the questions or the **presentation modes** exposed to the players. Additionally, as Nagle et al. (2015) suggest, adaption can be used to change visual elements as a simple and low-effort method to keep the enjoyment and attention in games. Further, adaptation may involve writing the rules of the game: for instance, what happens if the player achieves a certain amount of points? Will the new stage have more complicated tasks or challenges?

In that regard, **challenges** share with adaptation a critical factor in the balance between ability and difficulty to drive players to a flow state or to feel a certain level of competence. Hence, adaptation and challenge can be complementary elements, given that adapting the game by adding more enemies, reducing the health of the player, or adding limits (e.g. time or number of movements) results in more challenging tasks. Nevertheless, challenges can also mean that the players can set their own **goals** in the game to challenge themselves. The setting of their own goals (i.e. **customisation**) gives the players a sense of autonomy and control over the actions that they perform in the game. For example, players can have the ability to control the difficulty in the game, the look and feel of their avatar, the configuration of their vehicle (e.g. cars, spaceships, plains, etc.), and more. Customisation, whereby players are offered options to manage their own preferences is, thus, another element that can impact player enjoyment.

Once the players overcome the challenges, they can earn **rewards** which represent extrinsic motivators that increase the levels of presence. Further, if the rewards are based on personality traits, players can experience higher levels of enjoyment, perceived competence, and performance. Rewards come in different configurations, from simple congratulations messages to **points**, **badges**, **levels**, a position in the **leaderboard**, and more. However, regardless of the form, the player needs to observe that the rewards are meaningful. For example, when players earn points that represent in-game currency, they should be able to buy items with them to see the real value in their awards, or when

they only receive points, they should be able to see them on the leaderboards. Therefore, to maintain positive gaming experiences, the reward system should be well-designed, preferably taking into account the player's personality, but also by giving meaning to the extrinsic motivators.

Leaderboards which can represent rewards or progress in the game provide a way to compete with others, but their acceptance depends on the player's individual character traits. Researchers have found that the use of leaderboards predicts higher levels of enjoyment and higher levels of needs satisfaction for people with high levels of self-esteem or extraversion. Further, the position on the leaderboard also affects the experience and the levels of motivation for future play. Therefore, the inclusion of leaderboards provides a double motivation. First, as a personal goal, players can play to stay at the top. Second, they offer the players the opportunity to interact or compete with others by showing their achievements.

Applying **progress** as a design element involves showing the players' performance in the game through **levels**, **building a character** or even the **leaderboards**. The visual effect of progress motivates them to keep playing to open more levels or get more achievements.

Other GDE that also show information to the players are **game awareness** and **negative experiences**. Game awareness provides players with real-time information. This information guides them, supports their decision making, gives them knowledge of the danger, health, and even the presence of other players and their features. With that useful information, players enjoy the game more because they know what to do, how to react and play. Likewise, negative experiences can provide more awareness when the players know that the consequence of dying involves losing all the items collected previously. In that sense, players will search for strategies to stay alive, overcome the challenges, and continue playing the game.

More complex elements, such as **GPS-guided activities**, **simplified simulation**, **user-generated content**, **storyline**, **virtual pets**, **virtual rooms**, and **affective embodies agents**, represent more specific configurations of games. As such, they are more complicated to implement, but if the context and purpose of the game allow their integration, they can foster more enjoyment in the game. Similarly, more abstract elements, such as **aesthetics**, **interfaces**, **usability**, and **mechanics**, which include simpler components, can be used to enhance enjoyment. For example, colours, images, visual effects, the configuration of the elements in the screen, the options to close and pause the game, mechanics to include cooperation or competition, all together improve the aesthetics, the interface and the usability, which leads to more enjoyment.

Additionally, it is suitable to use elements that are in the *No impact* category (see Figure 4), such as feedback, rewards, customisation, competition, avatar, goals, points, and sound. Although they might not impact enjoyment or only partially, they can positively contribute to other factors, such as usability. For example, it is known that avatars contribute positively to players' definition of their identity and foster immersion (Birk et al., 2016). However, Jia et al. (2016) find a lack of value resulting in a demotivating element. Similarly, Forde et al. (2016) show that feedback impacts player experience and improves usability, but enjoyment results are not positive. This said, more research is needed on those GDE that show both positive and no effects on enjoyment (e.g. avatar, goals, sound, among others) to confirm or reject their effects on enjoyment.

Findings also unveiled a wide range of instruments to measure enjoyment based on grounded theory. Many of those measures are already well-established and thoroughly tested, such as PENS, IMI, and GEQ. Interestingly, several articles show that researchers tend to build their own instruments. This tendency complicates the analysis and comparison between studies. For example, Nagle et al. (2016b) evaluate the enjoyment with only one construct (enjoyment) while Johnson et al. (2018) use multiple constructs from IMI (competence, enjoyment, effort, and tension) and PENS (presence-immersion). Both studies report positive results on enjoyment. However, the differing number of constructs and results make their comparison almost impossible. Further, they may be evaluating different constructs within their studies. Therefore, to stimulate comparison and replication of the experiments, we recommend the use of the instruments identified in this study for future research. For example, if the research intends to measure the components of SDT to analyse how the satisfaction of needs affects the levels of enjoyment, IMI and PENS can be possible options as they are validated instruments. Furthermore, the combination of both is equally acceptable as researchers will be able to compare and verify their results by examining the subscales of the instrument (e.g. IMI-interest-enjoyment vs PENS-positive values in any of the subscales). Meanwhile, if the research focuses on flow, GEQ is the most suitable instrument to measure constructs of flow as it is another validated instrument (cf. Table 3 for an overview of all identified instruments).

Finally, it should be pointed out that most of the studies use subjective measures and just a few propose objective measures. The latter are generally used to correlate the results of the self-report measures. However, as they are

challenging to manage in terms of cost and utilisation (Emmerich et al., 2016), most of the researchers rely on using self-report instruments only to measure the player enjoyment. In that regard, we agree with the use of self-report measures only because they provide sufficient and valuable information about players' perception of enjoyment.

This study shows the variety of GDE and evaluates their potential to provide enjoyment to players. Although they have been presented as individual elements, the question, however, remains whether they can be used to design enjoyable games? In view of this, we conduct another study to extract the GDE from successful GWAP for linguistics to find out how these GDE have been used and to analyse whether they contributed to the success of these GWAP.

6. GWAP for linguistics

Games With A Purpose (GWAP) meant to create large annotated corpora constitute a promising approach within Natural Language Processing (NLP). They represent one of the most practical ways to obtain resources compared to high-cost and time-consuming manual data annotation or other data collection methods (e.g. Mechanical Turk) (Chamberlain et al., 2013). Furthermore, they can improve the accuracy of the output thanks to the consensus of multiple players. However, designing a GWAP for linguistics is a challenge because the linguistic domain introduces complex, specialised, and tedious tasks that are difficult to represent in a game in terms of understanding and entertainment for the player. Therefore, to ensure success in the creation of corpora, we need to ensure the attractiveness of games to engage the players to complete those tasks.

This study aims (1) to discover the relation between the identified GDE in the literature review and those used in the most successful GWAP for linguistics, and, to some extent, (2) to show that these design elements were a contributing factor to the success of these games. The next sections analyse two GWAP for linguistics and their respective GDE.

6.1. Method

This study focuses on two of the most successful GWAP for linguistics. The criteria to choose these games include having the highest number of annotations and the highest number of players among eight GWAP, about which we were able to gather results: (1) Phrase Detectives (Poesio et al., 2013), (2) JeuxDeMots (Lafourcade, 2011), (3) Zombilingo (Guillaume et al., 2016), (4) Puzzle Racer (Jurgens and Navigli, 2014), (5) Verbosity (Von Alu et al., 2006), (6) Wordrobe (Venhuizen et al., 2013), (7) PlayCoref (Hladká et al., 2009), and, finally (8) Infection (Vannella et al., 2014). Further, they need to have descriptions and results in English to facilitate the analysis. Phrase Detectives (PD) and Zombilingo (ZL) met these criteria. While PD recruited around 8000 players in 36 months while collecting 2,500,000 annotations (Poesio et al., 2013), ZL recruited 647 players in approximately six months and more than 100,000 annotations (Guillaume et al., 2016). These numbers reflect the high engagement of players because, despite the complexity of the annotation task, the games managed to create the necessary mechanisms to collect enough annotations to accomplish their goals.

6.2. Results

Phrase Detectives (Poesio et al., 2013) was designed to annotate and validate anaphora. The game design integrates a **detective analogy** where the player has to investigate if the highlighted text (markable) was mentioned before. It has two modes for playing: (1) annotation mode and (2) validation mode. In (1), the player annotates a markable with his interpretation, whereas in (2) the player has to decide on an interpretation from another player. The players receive training by means of a gold standard, which consists of text previously annotated by an expert.

The authors state that the game involves several tasks and uses scoring, progression and a variety of mechanisms to make it enjoyable. Although they do not mention assessing enjoyment through the application of any specific instrument or tool, they describe the personal, social and financial incentives used to encourage participation.

Personal incentives consist in scoring points and levels. The **scores** provide the players with a sense of progress and achievement and allow them to compete with others. The **scoreboard** or **leaderboard** motivates players to return to the game to visualise their score retrospectively, as they can earn points through the validation mode done by other players. Meanwhile, **levels** encourage the sense of progression, starting with the rookie level and progressing to the detective-related levels. Each level requires more points to achieve progression to the next one. Additionally, the game allows players to **choose the topic and complexity** of the texts, so it guarantees that players find them engaging as well as challenging, based on their personal preferences.

Social incentives include **competition with other players** and **collaboration within a community**. The first is achieved through making the scoring, levels and leaderboard visible to all players, whereas the second provides the opportunity to participate in the scientific community through the game.

Financial incentives are represented by small prizes for the highest-scoring players. The authors argue that despite having the enjoyment of the game as the main incentive, their experience suggests that prizes have a substantial impact but with a minimal cost.

Zombilingo (Fort et al., 2014) is a GWAP aimed to create a parsed French corpus. It was designed to annotate dependency syntax, which is established between a pair of words: the main or governing and the subordinate or dependant (Gelbukh et al., 2005). The game adopts a zombie **theme** to involve the players to earn brains (**points**) when they choose the requested element correctly. Researchers use the motivational factors Money, Ideology, Coercion/Compromise, and Ego (MICE) from the MICE framework to design the game in a more people-centred approach. The MICE include Money, Ideology, Coercion/Compromise, and Ego that researchers adapted as following: Money and Rewards, Ideology and Interest, Constraint and Retention, and Ego and Community (Fort, 2016). Money and Rewards consist of achievements (**scores** and **levels**) and **in-game currency**. Players get achievements by earning a predefined number of **points**; once they reach those points, the level and the **difficulty** increase. Further, they earn in-game currency, but only after completing more challenging tasks. Ideology and Interest include the theme of the game that attracts players to the **zombie universe** and the ability for players to **select the topics** that concern them. Constraint and Retention aim to encourage players by showing **leaderboards** that motivate them to pursue **daily or weekly objectives** to remain on the list of high-scores. Ego and Community include collecting **titles** and **in-game items** (cosmetic features that they buy with in-game currency) that players can show to other players, as well as the ability to communicate through a **social community** (forum) to discuss various phenomena.

As we have seen, the authors include design elements in the development of the game that could lead to enjoyment. Notwithstanding this, the assessment of the contribution of these design elements to enjoyment was not their focus. Thus, they report on a general level that gamification was essential to increase the amount of data collected (Fort et al., 2017).

6.3. Discussion

From the previous analysis, we find nine GDE in PD and twelve in ZL. Table 5 shows similarities in the use of GDE. Both games share the choice of text, community collaboration, leaderboards, levels, points, scores, and theme. Additionally, it shows that, for some GDE in the systematic literature review, more than one component identified in GWAP corresponds it; for example, rewards include in-game currency, in-game items, points, and more. Even though the explored GWAP do not report evaluations in terms of player enjoyment, both describe the psychological background of their decisions showing relations with the GDE found in the systematic literature review.

Table 5
Game design elements in PD and ZL, and their relation with GDE identified in the literature review.

GWAP elements	GDE	PD	ZL
Choose text complexity	Customisation	*	
Choose text topics	Customisation	*	*
Community collaboration	Social community	*	*
Competition with others		*	
Daily or weekly objectives	Goals		*
Difficulty	Adaptation		*
In-game currency	Rewards		*
In-game items	Rewards		*
Leaderboards	Leaderboards	*	*
Levels	Levels	*	*
Points	Rewards	*	*
Scores	Rewards	*	*
Game theme		*	*
Titles	Rewards		*

Customisation comprises choice of complexity level and choice of topic. GWAP researchers argue that the ability to choose the difficulty of the the game allows the players to align the challenge with their skills. At the same time, selecting a topic enables the players to choose more engaging texts. Hence, customisation not only gives simple options to the players, but also a sense of freedom and control, as well as a feeling of autonomy as defined in SDT. In this regard,

these GWAP are thus similar to the studies by Smeddinck et al. (2016); Ruehrlinger et al. (2018); Cuthbert et al. (2019), which present options to customise aesthetic or functional features which give players control over the game.

Although *social community* is not found in the literature review, it is associated with Relatedness in the SDT, Socialisers in the BrainHex model, and Agreeableness in the Big-Five Personality Traits. All of them emphasise the interaction between people as a motivator to engage with the game. In that sense, both games attempt to create forums where players can be part of the scientific community by playing or through discussing topics about the phenomena presented in the game.

ZL used *adaptation* to adjust the difficulty in each *level*. This feature not only provides a sense of progress, but in this case provides new challenges and complexity, similar to the adaptation based on the performance used by Mildner et al. (2015); Alves et al. (2018). However, the use of levels may not always be appropriate, given that only some type of players (people with high conscientiousness and extraversion) perceive levels as motivating (Jia et al., 2016).

Rewards combine all the features that the player earns through the game, including in-game currency, in-game items, points, scores, and titles. All of these are said to lead to higher levels of presence, immersion, interest/enjoyment, competence, and positive experience (Bui et al., 2020; Jia et al., 2016; Johnson et al., 2018; Nagle et al., 2016a; Vella et al., 2018).

Leaderboards are presented to the players to motivate them to return to play and to complete daily or weekly *goals* to stay at the top of the lists. Likewise, Sun et al. (2015) show that leaderboards help to attract the player to play again and Mildner et al. (2015) show that the use of a leaderboard encourages the players to reach better rankings and create competition. They also promote *competition with others* by showing the players' achievements. However, it is important to consider the target players carefully because, according to Birk et al. (2015a); Jia et al. (2016), leaderboards are enjoyable only for extroverted people or with high self-esteem. Other players may prefer to hide their results and compete with themselves instead.

Finally, both GWAP adopt a *theme* for their games: zombies and detectives. They use the theme as an analogy to show the activities of the game. However, they do not create a story around the topic to make the game more compelling and attractive for the players (Prestopnik and Tang, 2015). In that regard, Schell (2019) explains that the theme is mainly used to focus in the design toward something that holds meaning for the players, but the story goes deeper by immersing the player in a fantasy world. In this game world, players experience a narrative and the events might engage them more actively.

While the financial incentives could have attracted new players to PD, the results of both games suggest that the GDE played an essential role in engaging them. They provided full interaction between the game and the player. Without GDE, linguistic tasks become uninteresting or monotonous. Meanwhile, the combination of elements provide an entirely different perception of the activity. Players received feedback about their actions through points, rewards, challenges, and achievements, which motivate them to complete more rounds. In this analysis, we can see that those elements foster the engagement of players and give the GWAP the opportunity to accomplish their purpose. Additionally, the analysis also shows that the GDE used in GWAP for linguistics are consistent with some of the elements identified in the systematic literature review (Figures 2 and 3). From a design point of view, designers can rely on these GDE as resources to create enjoyable GWAP because they have been tested previously. Nevertheless, we cannot assure that their implementation will always impact the player enjoyment, given that other factors, such as the player's preferences, could affect favourably/negatively the impact.

7. General discussion

In this paper, we report the findings of two studies (i.e. a systematic literature review and an analysis of two GWAP for linguistics). The systematic literature review analyses the efforts in studying the breakdown of player enjoyment into GDE and their empirical evidence supporting their contribution to enjoyment. With this review, we aim to identify the effect of GDE on player enjoyment, their rationale, and the empirical support to their contribution. Our second study on GWAP for linguistics aims to decompose two GWAP. ZL and PD have reported the best results in the NLP research domain to reach out to a large number of participants and collect annotations. In the analysis, we find similarities with the GDE encountered in the literature. This demonstrates that those elements have the capacity to promote enjoyment in games to some extent.

The systematic literature review shows the great interest of the research community in empirical studies to support the creation of enjoyable experiences in games. Those empirical studies reveal multiple GDE that have proven their ability to foster enjoyment, such as rewards, adaptation, challenges, among others. Furthermore, our study finds

features that do not affect the enjoyment at all or do not obtain conclusive results, namely sound, feedback, avatars, among others. However, we also find that some of these elements are evaluated in only a few or a single experiment. Therefore, to give more validity to these results, we encourage future research to extend these findings by conducting more empirical studies.

This study also examines various instruments which can be used to evaluate the constructs of player enjoyment, including enjoyment, immersion, flow, positive affect, and presence. We find that even though some of these instruments are well-established questionnaires, the majority of the researchers prefer to design their very own instruments. We would like to encourage the use of well-established questionnaires as they have proven their usefulness in previous studies. We support their use to standardise future experiments allowing replication and comparison.

Finally, the study on GWAP for linguistics unveils that despite the lack of formal evaluation on enjoyment, the design decisions are consistent with our findings. The GDE used in these GWAP (e.g. rewards, adaptation, customisation, among others) and the overall design is able to attract many players and keep regular gameplay to collect a considerable amount of data.

7.1. Practical implications

Having a clear idea of the different GDE has practical implications for those who wish to develop enjoyable games in any field. Furthermore, current results also provide insights for future research endeavours.

In game design, designers can use the GDE shown in Table 4 as building blocks for their game concepts. They can identify the most evaluated and those with a positive impact on enjoyment. Further, we provide the full list of papers with their references (see Table 1) to find more details about specific implementations. In terms of evaluation, researchers can refer to the list of well-established questionnaires in Table 3 to evaluate the constructs of enjoyment. This list also shows the most used GDE to assess enjoyment or to evaluate other aspects that have an influence on enjoyment.

In game research, more research is needed to elucidate the role of some GDE. For instance, goals have been examined by Wang et al. (2015); Jia et al. (2016), yet the former conclude that they positively contribute to player enjoyment, while the latter does not find significant results in their data. We hope that this study (especially Figure 4) can help researchers with the identification and selection of GDE that need a systematic examination to determine their relationship with player enjoyment. However, we encourage the exploration of other sources for a specific game design element before planing an experiment because some studies might have been discarded due to our inclusion criteria.

7.2. Limitations and future work

The presented study has a few limitations. First, although we gathered many relevant papers across many sources, we found that some of the elements were evaluated in a few or only a single article. Therefore, to give more validity to these results, we encourage future research to extend these findings by adding empirical support from efforts in other areas and also by extending the search to older articles.

Second, we trusted the libraries' search engines from the publication databases. However, they may not filter the results appropriately or accurately. For example, in this study, to narrow the search down, the terms "games with a purpose" OR "serious games" OR "gamification" were specified, for which the search engine delivered articles based on those terms. But the search engine also provided papers (e.g. Petralito et al. (2017); Yildirim (2016)) on other research topics with minimal mention of the terms that passed the first filter of the procedure. This limitation did not affect the results of this review because those articles focused on player enjoyment (the main topic of this review). Nevertheless, it is recommended that researchers double-check during the screening criteria to ensure the papers delivered by the search engine focus on the researched topics.

Third, we relied explicitly on evaluations of the constructs of player enjoyment, including enjoyment itself, immersion, flow, positive affect, presence, among others. Notwithstanding this, we found other terms related to player enjoyment, such as playful, playfulness, playability, fun, game enjoyment, gameful, and gamefulness, that our screening and inclusion criteria excluded. Therefore, future work could establish a relationship between those terms and enjoyment to resolve if the GDE and instruments used to evaluate them can be included as part of the toolkit of design and evaluation for enjoyable games.

The present literature review was limited to understand GDE, and we found certain connections between them. However, we do not explore the effects of different combinations (e.g. whether a strong positive influence of a certain

game design element can be increased with another design element). Therefore, this is an interesting direction for future research to multiply the building blocks to design games.

Furthermore, given that the literature revealed the contributions to the constructs of enjoyment, they can be used to build heuristics, frameworks, or models that guide researchers in designing and evaluating enjoyable games.

8. Conclusions

This article contributes to synthesise current efforts in the areas of gamification, serious games and GWAP by analysing literature and identifying GDE aimed to improve player enjoyment. As the main result of this study, we find through a systematic literature review of empirical evidence, a variety of components that enhance the levels of enjoyment, such as, adaptation, challenges, customisation, rewards, and more. Their combination and balance foster players' enjoyment during gameplay and motivate them for future play. Furthermore, the study also reports on well-established instruments based on theoretical models of SDT and Flow such as IMI, PENS and GEQ to assess the enjoyment. Future experiments can use those instruments to evaluate new elements or elements that need further evidence. Consequently, in terms of design and evaluation, having GDE and instruments to evaluate them are starting points for designing enjoyable games.

Additionally, the second study examines the GDE used in GWAP for linguistics. Findings reveal that some components are consistent in both studies giving the researchers confidence to use the GDE as building blocks to build their game concepts.

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