The Meaning of Life (in Video Games)

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Abstract. This paper explores how the concept of life has been used in video games through time. Life is an essential element in different types of action games and several nuances have been used to provide various types of emotions and effects during gameplay. However, the details and patterns have not been extendedly analyzed. Primarily, we survey works regarding the description and formalization of game analysis with emphasis on works in which the concepts have impact in the arguably accepted notion of life. Multiple examples are provided to show different approaches to the concept of life and the impact of such approaches in overall gameplay, namely in the game difficulty and emotions. The examples are then generalized, resulting in a proposal of framework to describe life representation in games. The proposed framework was evaluated in a user study, having participants with gaming culture (professionals, academics, and students of game development courses). Each participant was assigned with the task of fitting a preselected set of games within the framework. The results indicate good coverage of the main concepts with satisfactory consistency.

Keywords: Game Terminology · Life · Game Design · Game Analysis

1 Introduction

The challenge of formally analyzing games is present since their establishment as a popular medium. Some media have more concrete methods (for instance, music theory has very systematic methods to define concepts such as rhythm, harmony, and melody) while others are more abstract and conceptual (for instance, one can recall the art piece that consists of a banana taped on a wall [1]).

Regarding core game design process, one of the pioneer approaches is the MDA (Mechanics-Dynamics-Aesthetics) Framework [2], which formalizes the consumption and the design of games, presenting a formal way to bridge the two parts of the process: designers and players. The MDA Framework is a solid reference that brought attention to important aspects of the design process and is widely used and adapted. However, some of its elements lack some pragmatism to be widely used in the industry. Additionally,

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the MDA is flexible and adjustable. For instance, it starts with a set of aesthetics that is explicitly stated to be nonexclusive and modifiable. While this flexibility allows different mindsets, it also compromises systematization.

One of the main efforts to systematize video game concepts is the Game Ontology Project (GOP) [3], which can be summarized as a hierarchy of concepts abstracted from an analysis of many specific games. The work "identifies the important structural elements of games and the relationships between them, organizing them hierarchically" [3]. In this paper we focus the study of a particular aspect used in video games since their dawn: the concept of life. This concept is indeed pointed in the GOP hierarchy under the top-level entry "rules". Examples are presented, but there is room for improvements and research, as this is a core element of gameplay. As will be further discussed in Section II, some game design books also describe life and present use cases but, in general, there is a lack of a defined set of terms to allow the establishment of game design patterns. This is precisely the main goal of this work: present a framework to describe the structure of lives in video games (where applicable) and to analyze how different configurations within that structure can impact gameplay.

The paper is organized as follows: Sect. 2 reviews related work previous attempts to formalize the concept of life in video games; Sect. 3 presents the proposed framework through a description of its main components, which are decomposed in a set of attributes with specific data types; Sect. 4 describes the methodology and results of the user study conducted to validate the proposed framework; Sect. 5 presents concluding remarks and a discussion of our results and future works.

2 Related Work

2.1 Initial Concept of Life

The basic notion of life in video games is widely perceived and supported by literature. Orland et al. [4] provide a dictionary of gaming terms for the press where life is described as a play-turn that a player has between the start and the end of play. The GOP [3] defines life as something to "represent a measure of opportunities that a player has to succeed in the game". Rouse III [5] refers to lives as a finite number of tries before the "game over" state, which is the ultimate penalty for running out of lives. Lecky-Thomson [6] details the concept of lives and presents some examples. Space Invaders is referred as the pioneer where lives soften the impact of losing similarly to having multiple balls in a pinball machine. Checkpoints and saving are terms that are also presented as work as a continuation of the concept. Additionally, other features related to the concept of lives are identified, namely: defensive armor, power-ups, weapons, or ammunition that somehow cancels or softens the usual penalty associated to being hit (this feature is corroborated by Fullerton [7]), and items or power-ups that allow (re)gaining life (this feature is also referred by Moore [8]).

2.2 More Than Just Life: Hit Points and Health Points

The concept of health is commonly referred similarly to the notion of life in gaming literature. It can be seen as an evolution of basic principles of multiple retrying options,

with more variants. It is normally designated by the acronym HP, standing either for Health Points or Hit Points [9]. In both cases, it represents the "total amount of damage a unit can withstand before being rendered incapable of participating in combat" [8]. This is valid for players, that will lose the game, opponents that will be overcome by the player, and even objects within the environment [10].

The notion of HP presents different benefits for game design and gameplay, such as simplifying the design process and rule balancing, and is a simple and effective way that "both players and computers can easily work and understand" [11]. It is also effective to give the feeling of progression by making the player start with a small number of points that can increase during the game [12]. Additionally, it is possible to stack extra rules or expand the concept to allow more complex systems that a set of hardcore players enjoy (e.g., the health points can be associated with different parts of the body, armor, or equipment). It is also common to have some mechanism of additional protection that prevent or reduce the loss of health points when the player is hit. They can take the form of shield, armor, or any another equipment, but the common notion is that is something that protects the player in case of being hit.

2.3 Other Approaches for Life Representation

The basis of the concept of life played an important role in the early days of video games, providing a desire to avoid the finality of the player character's death and inciting players to spend more coins in arcades (increasing the final profit [13]). With the evolution of games, it also evolved and gained different purposes, such as expanding gameplay, evoking emotions, providing monetization methods, etc. Many contemporary games do not use a direct representation of life as an isolated element, but combine different approaches for life, health (or hit) points, and protections. Also, life is represented differently among games and there are distinct interpretations and meanings to allow retries. For instance, in the Uncharted series (2007 - 2017) "life" is a luck meter of being critically hit and in the Assassin's Creed series (2007 – 2020) it is a measurement of synchronization with past events. With all the existing possibilities, the main concepts are informally used and perceived but there is a lack of formalization and systematization of the main existing entities and their attributes.

3 Proposed Framework

Considering the literature review on the different representations of life, including variations of game genre, style and even development limitations, we have analyzed how the different concepts stack on the gameplay structure, and extracted the interdependency among them. As a result, we identified the whole existence of a gaming character in an action game to be decomposable with the following four elements: Credit; Life; Energy; Protection. These elements provide different levels to handle the consequences of failing challenges within a game and will be described next.

Credit – Represents the access to play a game session and is an allowance to enter or be kept in the game world, regardless of the features of the player's character. This top-level concept gets its roots in arcade machines, in which inserting a coin would allow

one game credit to play the game with its respective rules (e.g., number of tries, time, or other restrictions). Though the existence of credits is strongly associated with the monetization model of the arcade machines, it is still applicable nowadays. Normally, games that are bought with a premium model provide infinite credits, but many free games have a monetization model that include the notion of credit, where watching ads replaced coins as currency. Credits are composed by the following attributes:

- Mechanism, that describes how players earn credits and has the following values: Infinite; Payment (limited); Payment (without limits); Predefined value (of 2 or more); One credit only.
- Penalty, stating what happens when the player loses a credit. This enumeration has the following values: seamless continue; respawn on the same position; respawn at a previous checkpoint; level restart.

Life – Represents the possibility of retrying the challenges of the game. While credit is focused on the world, the concept of life has focus on the player. A new life implies the existence of a new instance of the player in the world, in which the last instance was lost (died, was destroyed, etc.). As we have seen in the literature review, the essence of this concept is present since the early days of gaming and is universally considered in gaming culture. Even though it makes more sense in the context of living characters, the popularity of the term allows its usage for any other type of representation in a game, such as vehicles, or even in more abstract scenarios such as quizzes. The element life is composed by the following attributes:

- Mechanism, defining the way for its representation and having one of the following alternatives: One; Multiple; Infinite.
- Penalty, stating what happens when the player loses a life. This enumeration has the following values: seamless continue; respawn on the same position; respawn at a previous checkpoint; level restart.
- Methods to earn life, which present the different ways to obtain additional lives during gameplay and can be described as a multiple selection enumeration with the following values: Performance (for instance the player's score); Pick-up; Tradable.

Energy – Represents the capability that allows players to sustain injury, damage or partially fail a challenge without implying the death or destruction of their avatar. In our literature review we have observed that the most common designation for such type of representation is HP, standing both for Health Points and Hit Points. In both cases, the designation has some restrictions. Health implies a living character and is not adequate for vehicles and other non-living entities controlled by the player. Hit implies damage through physical threats on the level and may not depict well situations in which the character is poisoned, is stepping on a hazardous surface, or other similar situations that can happen in any video game. Therefore, for our framework, we propose the use of the broader term energy, composed by the following attributes:

- Mechanism, defining its representation and having the following values: continuous; discrete; hidden (with feedback for critical levels); hidden (without any feedback); inexistant (player loses one life directly when is hit).
- Penalty, stating what happens when the players lose energy. This enumeration has the following values: seamless continue; visual feedback; impact on movement.

- Regeneration methods, which present the different ways to restore some (or the totality) of the player's energy. They can be described as a multiple selection enumeration having the following values: automatic (regenerated with time according to a specific rate); through equipment; pick-up; tradable; items.

Protection – Refers to the player's capability to prevent, be immune, or mitigate the effects of something that, in regular cases, would result in loss of energy. This is specifically an external optional layer that protects the player, in opposition to energy that is internal to the player. Protection has the following set of attributes and features:

- Mechanism, representing the behavior of the player protection mechanism, which can be: a time-interval; a specific amount; based on endurance; inexistant (players lose energy whenever they are hit).
- Type, representing the degree of protection given to a player, which can have the following values: full (full protection against all threats); partial (only protecting from a specific set of threats – e.g., only from magical damage).
- Penalty, stating what happens when the players lose part of their protection. This is an enumeration with the following values: seamless continue; visual feedback; impact on movement.
- Regeneration methods, which present the different ways to restore some (or the totality) of the player's protection. They can be described as a multiple selection enumeration having the following values: automatic (regenerated with time according to a specific rate); through equipment; pick-up; tradable; items.

Regarding the methods to earn life, energy and/or protection we referred the terms pick-up, item, equipment and tradable. For this matter, a pick-up should be considered as something that the player collects and use immediately, in opposition to items or equipment that are carried in an inventory and used when the player wants (for items) or selected for continuous use (for equipment). Tradable refers to items or equipment that can be exchanged for something directly obtainable in the game (for instance, the player can collect coins that are used in a store to buy life/energy/protections).

A visual representation of the concepts used in our framework is presented in Fig. 1. Credit provides entrance to the game world and protection, energy, and life are all focused on the Player and act as layers to handle threats. Each layer acts sequentially, filtering the potential damage of the threats that hit the player. An initial layer of protection filters and/or absorbs the damage. In case of partial filtering or absorption, the remaining effects of a certain threat can pass to the next layer, which will receive the remaining damage (i.e., part of the damage will be absorbed by the protection layer). Running out of Energy implies losing a Life, which does not occur with the Protections, that are external elements (players can run out of protection without losing energy or lives, but if they run out of energy, they lose a life). In the same manner, running out of lives implies losing one Credit.

Our framework aims to cover the main alternatives that were used in games to represent life to allow the player to fail and retry in action video games. As this first creation has its natural shortcomings, it intends to cover a large set of games that could be expanded in the future while enlightening the contours of its applicability. Currently, we have perspectives that the framework can be used in the following scenarios:

- Study of existing games, to analyze and compare games and extract design patterns that are used to create some kind of emotional responses.
- Development of new games, as it serves as a checklist of features that must be defined for a regular action game.
- Development of game-like experiences outside gaming context, where having proper game design and game culture knowledge is useful, such as gamification [14] and serious games [15].

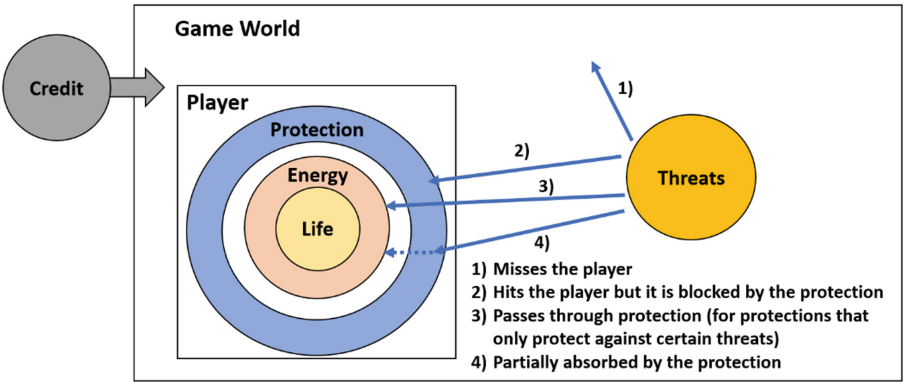

Fig. 1. Representation of the main concepts of the framework.

4 Evaluation

4.1 Goal and Methodology

The proposed framework aims to allow analyzing existing games and compare them regarding life representation. Such comparisons push a better understanding about game design patterns that promote certain effects regarding challenge and difficulty. Also, it aims to aid the design process, promoting a guide to cover the different aspect to consider. Considering these goals, we conducted a study to analyze and evaluate the completeness and consistency of the proposed framework.

The evaluation procedure adopted in the study consists of asking participants to fit popular single-player action games within the framework. This experiment was conducted with academics, professionals, and students with a connection to game development area. We consider that a game fits the framework if it is possible to describe its approach regarding life representation with the elements of a framework by filling a form, without requiring additional explanations. The percentage of analyzed games that fit the framework represents an indication of its completeness. Consistency is analyzed by comparing different responses within the same game (the similarity of the responses indicates the consistency of the framework).

The set of games used in the experiment aims to represent the general gaming history and multiple genres where life is an important gameplay element (for instance, graphical

novels were not considered). For this matter, we started with a list containing the best games of each year for the most popular magazines. Games that could not fit the action genre were removed (i.e., games where life is not a relevant element of the gameplay). In addition, games that represent a continuation of a franchise were also removed (except in cases where significant gameplay differences are known).

The framework was tested by 43 participants, including game development students from two different universities, professors, and industry professionals. At the beginning of the experiment, participants were briefed about the goal and the concepts of the framework, and then they were asked to anonymously fill a form where they could select a game (from the selected set of games) and classify the different features of the game within the concepts of the framework. In the form, every main component (credit, life, energy, and protection) had a free text field in which the participants could indicate game features that were special and could not be described only by the terms of the framework. The participants could fill the form many times as they want for different games. In total, we received 87 analyses for the selected set of games. After excluding games with less than three different analyses, we obtained a study set with a total of 82 analysis covering the 16 different games (an average of 5 analysis for each game) that will be explored thereafter.

4.2 Results and Discussion

To analyze the results, we compared the answers obtained for the questions related to the different elements of the framework in each game. For the evaluation of the consistency, each element of the framework was tagged as:

- **Consistent (C)**: for cases in which all responses were the same.
- **Inconsistent (I)**: when responses were different without a recognizable pattern.
- **Arguable (A)**: for situations in which the responses were not the same but there is a plausible and meaningful cause for that. These cases will be further discussed.
- **Not Applicable (N/A)**: when another answer cancels the meaning of the element (for instance, with infinite lives, the ways to increment life does not apply).

The results obtained in the comparison of the answers for each element of our framework are presented in Tables 1, 2, 3, and 4 (each table contains de results regarding credits, lives, energy, and protection, respectively).

Initially, we were expecting to analyze mainly the percentage of consistent cases within the domain of applicable features to evaluate the consistency of our framework. However, the percentage of consistent elements was below our expectations (around 65%). This made us observe with more detail the possible causes of potential inconsistent cases and we have identified multiple justifications that do not imply bad consistency. Some of them also show the potential of the framework to incite further studies. These cases were tagged as Arguable and represent the following situations:

1. **Some responses mix multiple versions of a franchise or platform** – In some games, in which Doom was the most obvious one, the responses were divided into two obvious clusters with barely identical answers in each cluster. By observing the differences between the groups, we could imply that some responses considered the original version of Doom, while the others considered the 2016's version.

2. **Having infinite retries was not clear** – In contemporary games with premium models, it is common to have infinite lives and/or credits. For instance, in Uncharted, the player dies and restarts in a checkpoint, without any limit. There was a natural confusion within participants in interpreting this situation as 1 credit with infinite lives or infinite credits with only 1 life. Based on the definition of our framework, we consider that these situations mean infinite lives, as the player effectively dies in the game, but the right of play is not revoked for that.
3. **Participants forgot some details** – Typically, in responses regarding methods to regenerate energy or protection, some details were missing in the analyses. One situation that occurred multiple times was having some participants stating that energy or protection could be gained with pick-ups and items, while a few only referred pick-ups. These cases reflect that some analyses are incomplete.
4. **Different game modes** – As some participants stated in the comments, some games, particularly multiplayer, have different game modes and the answer depends on the considered mode. Some inconsistencies of Counter-Strike, League of Legends, and Overwatch are due to this fact.
5. **Difficulty levels** – As claimed in a few comments of the participants, sometimes the difficulty level implies different approaches in the framework features. Before beginning the tests, we have already thought about difficulty, as it is straightforward to perceive that the definition of the features depends on that. One obvious example is having a different number of energy blocks for different difficulty levels. However, the differences might be stronger. A game with a harder mode based on permadeath has two different approaches for life mechanism, an easier one with some or infinite lives, and another one with only one life. In these cases, different difficulty levels should be considered as different game versions.
6. **Different types of projectiles inflict different reaction on the player** – Regarding the penalty for losing energy, there were some inconsistencies, in which some responses for the same game stated that there was impact on gameplay, and other stated that there was no impact. This happened specially on shooting games, which made us identify the fact that, in some games penalty of losing energy may depend on the type of threat. For instance, being hit by a pistol bullet may not imply impact on the player movement but being hit by a rocket will.
7. **Visual feedback penalty is ambiguous** – We have identified some inconsistencies in which, for the same game, different participants stated that the game has visual feedback for being hit while others did not. There are different possible causes for this, as the subtilty of feedback or misinterpretations of what this may mean. We believe that is important to clarify this term in the future, especially to expand the term to any type of feedback (for instance, audible feedback).
8. **Different characters may imply strong differences in gameplay** – Regarding Overwatch, some participants stated in the comments that the game characters are associated with classes and that different classes imply different features. For instance, one class might have an energy regeneration method that is different from another class. This might be the main reason of the inconsistency of this feature. Regarding game analyses, we consider that cases of specific character classes, as well as stated with difficulty settings, should be analyzed as different games. This means that playing with a character of a certain class results in a different game in comparison to playing

with a character of another class. While this consideration might be arguable, we can consider it for evident cases in which the player can choose or use characters with very distinct abilities. For instance, the multiplayer mode of Sonic puts the players in control of very different characters, as the second player plays with Tails, a character that can fly, also having infinite lives.

Table 1. Overview of the results regarding Credits.

Game	Mechanism	Penalty	Comments
Doom	Arguable	Arguable	No
Counter-Strike	Consistent	Consistent	Multiple
Super Mario Bros	Arguable	Arguable	No
Uncharted 4	Consistent	N/A	No
LittleBigPlanet	Inconsistent	Inconsistent	No
League of Legends	Consistent	Consistent	Multiple about the increase of cost for credit
God of War	Arguable	Consistent	No
Overwatch	N/A	N/A	No
Diablo II	Consistent	Consistent	1 about difficulty levels
Sonic Hedgehog	Consistent	Consistent	Multiple
GTA V	N/A	N/A	No
The Last of Us	N/A	N/A	No
Tomb Raider	N/A	N/A	No
Donkey Kong	Arguable	Arguable	No
Frogger	Consistent	Inconsistent	No
Prince of Persia	Consistent	Consistent	No

Table 2. Overview of the results regarding Life.

Game	Mechanism	Penalty	Comments
Doom	Arguable	Arguable	No
Counter-Strike	Consistent	Consistent	Multiple
Super Mario Bros	Arguable	Arguable	No
Uncharted 4	Consistent	N/A	No
LittleBigPlanet	Inconsistent	Inconsistent	No
League of Legends	Consistent	Consistent	Multiple about the increase of cost for credit
God of War	Arguable	Consistent	No

(*continued*)

Table 2. (*continued*)

Game	Mechanism	Penalty	Comments
Overwatch	N/A	N/A	No
Diablo II	Consistent	Consistent	1 about difficulty levels
Sonic Hedgehog	Consistent	Consistent	Multiple
GTA V	N/A	N/A	No
The Last of Us	N/A	N/A	No
Tomb Raider	N/A	N/A	No
Donkey Kong	Arguable	Arguable	No
Frogger	Consistent	Inconsistent	No
Prince of Persia	Consistent	Consistent	No

Table 3. Overview of the results regarding Energy.

Game	Mechanism	Penalty	Increment	Comments
Doom	Consistent	Consistent	Arguable	No
Counter-Strike	Inconsistent	Inconsistent	Consistent	Multiple
Super Mario Bros	Inconsistent	Inconsistent	Consistent	No
Uncharted 4	Consistent	Consistent	Consistent	No
LittleBigPlanet	Inconsistent	Inconsistent (completeness)	Consistent	No
League of Legends	Consistent	Inconsistent	Consistent	Multiple about stealing energy
God of War	Consistent	Consistent	Consistent	2 referring regenerative item
Overwatch	Consistent	Consistent	Inconsistent	Multiple about being revived and the existence of classes
Diablo II	Consistent	Consistent	Inconsistent	Multiple, specifying the increment methods
Sonic Hedgehog	Consistent	N/A	N/A	1 about rings as protection
GTA V	Consistent	Consistent	Consistent	1 referring regenerative item
The Last of Us	Consistent	Consistent	Consistent	No
Tomb Raider	Consistent	Consistent	Inconsistent	No

(*continued*)

Table 3. (*continued*)

Game	Mechanism	Penalty	Increment	Comments
Donkey Kong	Consistent	N/A	N/A	No
Frogger	Consistent	N/A	N/A	No
Prince of Persia	Consistent	Inconsistent	Consistent	No

Table 4. Overview of the results regarding Protection.

Game	Mechanism	Representation	Penalty	Type	Absorption	Increment	Comments
Doom	A	A	C	C	C	C	No
Counter-Strike	C	C	I	I	I	I	Multiple
Super Mario Bros	A	A	A	A	A	A	No
Uncharted 4	C	N/A	N/A	N/A	N/A	N/A	No
LittleBigPlanet	C	N/A	N/A	N/A	N/A	N/A	No
League of Legends	A	A	A	A	A	A	Multiple*(a)*
God of War	C	N/A	N/A	N/A	N/A	N/A	2 *(b)*
Overwatch	C	C	A	A	A	A	Multiple*(c)*
Diablo II	I	I	I	I	I	I	1 *(c)*
Sonic Hedgehog	C	C	C	C	C	C	1 *(d)*
GTA V	C	C	C	C	C	I	1 *(a)*
The Last of Us	C	N/A	N/A	N/A	N/A	N/A	No
Tomb Raider	C	N/A	N/A	N/A	N/A	N/A	No
Donkey Kong	C	N/A	N/A	N/A	N/A	N/A	No
Frogger	C	N/A	N/A	N/A	N/A	N/A	No
Prince of Persia	C	N/A	N/A	N/A	N/A	N/A	No

C – Consistent; I – Inconsistent; A – Arguable; N/A – Not Applicable
(a) referring which items protect. (b) about using the shield in gameplay.
(c) about the existence of classes. (d) stating that there are 2 different protections.

The identification of some of the previous cases let us retag some of the features as arguable instead of inconsistent, reducing the initial set of inconsistencies to around 25%. If we divided the analyses for Doom into two different games this value would lower to 20%, resulting in 80% of arguable consistency.

For the evaluation of completeness, we analyzed the comments of the open fields of the form. Most of them were descriptions of what they have considered and do not imply a lack of completeness of the framework. For instance, in different answers, the

participants stated that some games have pick-ups to restore energy, and in the open fields they listed which pick-up are those. Still, within the comments, we were able to identify three main limitations of the framework, which are described next.

Lives associated to checkpoints – Little Big Planet raised this limitation, as the game has a different life system. In this game, when the players die, they return to a checkpoint, obviously represented as circular marks. The number of lives is associated to checkpoints, meaning that the player can reappear N times in each checkpoint. Also, there are different types of checkpoints, providing 3, 6 or infinite respawns. The framework does not have a definition for this mechanic.

Specific multiplayer modes – Some multiplayer games provide different modes, which lie outside of the representability of the framework. Examples of such cases include game modes based in a last man standing concept, popularized in battle royale games as Fortnite; games consisting of rounds with teams that adopt a paintball mechanic, which forces players to wait for a new round when they die; and team-based games that offer the possibility of having players healing other players.

Stealing energy – Some participants referred in the comments that in League of Legends, one specific way to regain energy is by stealing it from other characters. This aspect was not in the framework.

5 Conclusions

In this paper we explored the different representations of life in video games. While this is a widely used terminology, there is a lack of formal definitions to characterize it. Therefore, we have defined a framework to describe life related concepts. The concepts of the framework were presented and discussed with students of 3 different universities with game development courses, and it was particularly interesting to gather their opinions and observe the fomented discussions. For instance, the rings in the game Sonic raised various debates about if they should be considered energy or protection. This was surely a positive effect, as well as the fact that, in the end, after exploring the impact on gameplay, they normally converged to a consensus.

In our study, we analyzed a set of popular games within the framework to understand its consistency (similarity between analysis) and completeness (most of the situations are describable within the framework). For 80% of the analyzed features, the framework is arguable consistent, a promising result, as this is, as far as we know, the first strong effort on this subject. We have also identified the causes for some of the inconsistencies, so improved versions of the framework can already be envisaged.

Regarding completeness, we have identified three cases where games presented mechanics that did not fit the framework. Considering that 16 games were analyzed within four main classifications, and that the identified cases apply to only one of the categories, the issues are related to only 3 cases (out of 64). The situations of having lives associated with checkpoints and stealing energy from characters is something to be included in a next version of the framework, to improve its completeness. The limitations regarding multiplayer modes require a more in-depth study.

The set of games used to validate our framework was defined starting from a list of the best games for each year, selected by reputable video game journalists or magazines.

This choice provided a neutral and unbiased test set but left out an important segment of the game market, which is the mobile gaming market. The concept of credit was popular in arcade games and lost its presence in games in home consoles. However, the monetization models based in ads, common in free games for mobile platforms, brought a new approach to credits that is worth studying. Future research should also consider the versions and platforms of the games being analyzed, which can lead to comparisons of how the same games are represented in multiple platforms.

Finally, further developments should also consider a possible improvement regarding the description of the framework with a more formal mechanism and/or language. This might also lead to studies analyzing if more formal representations can contribute to a better understanding of the framework concepts.

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References

1. Bryzgel, A.: The $120,000 banana: how to have your art and eat it. The Conversation. https://theconversation.com/the-120-000-banana-how-to-have-your-art-and-eat-it-128571. Accessed 30 May 2023
2. Hunicke, R., Leblanc, M., Zubek, R.: MDA: a formal approach to game design and game research. In: Proceedings of the Challenges in Game AI Workshop, 19th National Conference on Artificial Intelligence. AAAI Press, San Jose, CA (2004)
3. Zagal, J. P., Bruckman, A.: The game ontology project: supporting learning while contributing authentically to game studies. In: Proceedings of the 8th International Conference on International Conference for the Learning Sciences - Volume 2 (ICLS'08). International Society of the Learning Sciences, pp. 499–506 (2008)
4. Orland, K., Thomas, D., Steinberg, S.: The Videogame Style Guide and Reference Manual. Lulu.com, Morrisville, NC (2007)
5. Rouse III, R.: Game Design: Theory and Practice (2nd ed.). Jones & Bartlett Learning, Burlington, MA (2004)
6. Lecky-Thomson, G.: Video Game Design Revealed. Course Technology, Boston, MA (2007)
7. Fullerton, T.: Game Design Workshop: A Playcentric Approach to Creating Innovative Games, 4th edn. A K Peters/CRC Press, Natick, MA (2018)
8. Moore, M.: Basics of Game Design. A K Peters/CRC Press, Natick, MA (2011)
9. Carreker, D.: The Game Developer's Dictionary: A Multidisciplinary Lexicon for Professionals and Students. Cengage Learning, Boson, MA (2012)
10. Brathwaite, B., Schreiber, I.: Challenges for Game Designers. Charles River Media, Boston, MA (2008)
11. Adams, E., Dormans, J.: Game Mechanics: Advanced Game Design. New Riders, Indianapolis, IN (2012)
12. Adams, E.: Fundamentals of Game Design, 2nd edn. New Riders, Indianapolis, IN (2009)
13. Rogers, S.: Level Up! The Guide to Great Video Game Design, 2nd edn. John Wiley & Sons, Hoboken, NJ (2014)
14. Huotari, K., Hamari, J.: Defining gamification. In: Proceeding of the 16th International Academic MindTrek Conference on - MindTrek ' vol. 12, p. 17 (2012)
15. Prensky, M.: Digital Game-Based Learning. Paragon House, St Paul, MN (2007)