Journal of Digital Media & Interaction
Vol. 1, No. 2, (2018), pp. 7-24

A Model for the Quantitative Assessment of Freedom of Choice in Adventure Digital Games

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Abstract

The concept of freedom in player interaction with digital games, the nature of the choices that make it up and the subjective assessment as to whether a game is considered free-form or structured are at the heart of the interest of this paper. Free-form games that give room to many different player-generated gameplay paths may amuse a player, while structured games that constrain players to follow a single path to one objective may bore them, thus resulting in different styles of interaction with this specific type of digital media. The aim of this study is to contribute to formalizing a concept of freedom of choice, and be able to evaluate its presence/absence in different adventure digital games; more specifically, the research aims at the formalization and, eventually, at the quantitative assessment of a concept of freedom of choice in free-form and structured adventure digital games, and attempts to arrive at a typology that allows different adventure digital games to be placed at various points on an axis between totally free-form activity and formally structured goal-driven activity. This effort, at the same time, is contextualized within a broader research plan for using adventure games as digital media-based learning frameworks, with a view to ultimately taking stock of player experience and interaction drivers, such as freedom of choice, as enablers for better player/learner engagement and more effective learning through these media.

Keywords: adventure games, games for learning, freedom of choice, free-form gameplay, structured gameplay, digital media interaction

1. Introduction

An essential part of the quality of digital games that makes them successful, engaging, and enjoyable is player experience (PX) which is generated during a game play session. Player experience can be broadly defined as the experience of play, which includes elements such as how well the game supports and provides the type of fun players want to have, and what makes players having fun. Player experience describes the personal, transient and dynamic qualities an individual player experiences from interacting with a game (Wiemeyer et al., 2016). According to Roto (2007), there are 3 phases of player experience: (a) expected player experience (before a player starts to interact with a game), (b) player experience during interaction (experience that takes place while interacting with the game), and (c) overall player experience (experience after game ends). What Roto (2007) is emphasizing is that the interaction phase is definitely an important phase to affect player experience. Investigating the player experience during interaction is significant in order to improve a game, as it is in this phase that features and components which create positive experience and others which do not can be observed.

Furthermore, Hassenzahl and Tractinsky (2006) argued that an experience is a unique combination of various elements, such as the system (e.g. complexity, purpose, usability,

ISSN: 2184-3120

functionality, etc) and internal states of the user (e.g. mood, expectations, active goals), which extends over time with a definitive beginning and end. During a play session all these elements interact and modify each other. The outcome of this process is the actual player experience.

A digital game, as a system, has two sets of features which affect player experience and enhance interactivity. The first set of features is the mechanics of the game. The mechanics are methods invoked by players for interacting with the game world, including goals, rules and rewards (Almeida, 2013; Egenfeldt-Nielsen, Smith, & Tosca, 2008). Goals are what a player must do and accomplish in order to progress or win in the game. Rules are the laws that determine what can and cannot happen in the game (Salen & Zimmerman, 2004). Rewards are something a player receives in return for completing goals or specific objectives, tasks and challenges. The second set of features is the interface including visuals, audio and feedback. Visuals are related to how the game looks, in two or three dimensions. Audio is the game's sounds, sound effects and music, equally important when compared to visuals in creating atmosphere and for player feedback. Feedback is the game's response (visual or audio) to players' actions (Adams & Rollings, 2007).

As Ermi and Mayra (2005) and Newman (2008) argued, digital games were brought to life through the interaction between the player and the system. That said, our research interest focuses on the concept of freedom of choice as a factor that affect this interaction. Freedom of choice is such a significant component to games, that it has been argued by Domsch (2013), that part of the appeal of games lies in their promise of agency, which is dependent on player and her choice. It allows players to examine the different available choices and to enact new and sometimes unanticipated forms of gameplay that may emerge from the exploitation of unintended situations and the consequences of certain inputs, or combinations of gameplay operations (Ashton & Newman, 2010). The existence of freedom of choice, which imply differing outcomes, heightens the freeform gameplay by forcing the player to make differential evaluations of multiple options.

In the light of the above, this paper aims at the formalization and quantitative assessment of structural freedom of choice in a number of selected free-form and structured digital adventure games in order to arrive at a typology that allows different digital adventure games to be placed at various points on an axis between totally free-form activity and formally structured goal-driven activity, and (b) cross-examination of the indication that a high degree of structural freedom of choice ultimately leads to greater dynamic freedom.

2. Background concepts and research

2.1 Structural freedom of choice and dynamic freedom of agency

As there are games that have developed rules to limit the freedom of choice that players have (Arvidsson & Sandvik, 2007; Domsch, 2013; Sotaama, 2010) and games that allow players to act in order to develop and progress the game plot (Cardoso & Carvalhais, 2013) in which the number of choices is still indefinite (Domsch, 2013), the first differentiation that one needs to make is related to the ways in which the concept of freedom of choice is provided by the game system.

In this broadest sense, we speculate that there are two forms of freedom into games: (a) the structural freedom of choice, which is integrated into the structure of the games by the game designers and (b) the dynamic freedom of agency, which is activated or not by the players during the gameplay. It should be emphasized the importance of players' perspective, which affects the dynamic freedom of agency, as well as its differentiation from the structural freedom of choice that is offered by the game system. The dynamic freedom of agency, which is more rightly reflected by the concept of player agency, according to Eichner (2014), is neither a characteristic of the medium nor is it interactivity; it lies in the perception of the player. Janet Murray (1997), who is often quoted as the founder of agency in game studies, clearly expressed the importance of players' perspective by argued that digital games present ideal circumstances to enable this “feeling of freedom” in its different implementations, as on games we encounter a world that is dynamically altered by our participation.

Furthermore, the assessment of the structural freedom of choice is distinct from the way that players themselves evaluate, positively or negatively, the dynamic freedom of agency and our previous studies (Kirginas, S., & Gouscos, 2016a; Kirginas, S., & Gouscos, 2016b; Kirginas & Gouscos, 2017) have indicated that digital games with the greatest extent of dynamic freedom of agency led to better gaming experience than the digital games with lower extent of dynamic freedom of agency. Furthermore, the research findings showed that increases in the level of children’s positive experience are correlated with increases in the children’s willingness to play again the game. Therefore, freedom of choice is an important factor of positive gaming experience, and as such it should be optimized. The results of this studies show an important implication, that generally greater dynamic freedom of choice is, to a certain extent, evaluated more positively, and the dynamic freedom of agency that players activate during gameplay has dependence (and possibly barriers) on the structural freedom of choice that is offered by the game, so we are studying the latter.

2.2 Free-form and structured digital games: overview of current studies

Based on the work done by other scholars and ludologists in the past (Berger, Caillois, & Barash, 1963; Frasca, 2003; Mitgutsch, 2008; Salen & Zimmerman, 2004), we have thoroughly discussed in our previous studies (Kirginas, S., & Gouscos, 2016a; Kirginas, S., & Gouscos, 2016b; Kirginas & Gouscos, 2017) the theory that digital games categories can be considered to lie at various points on an axis between totally free-form activity and formally structured goal-driven activity:

(a) The formal end of the axis focuses on the game-dimension of game play, such as rules, goals and structures. These are “structured” digital games which are more strictly defined games: (a) they have an explicit set of winning and losing rules which force players to take specific paths to reach goals and ensure that all players take the same paths; (b) they have pre-determined and clear goals whether these are to beat players’ high score, progress to the next level or complete the game in full, etc.; (c) they provide immediate feedback which lets players know immediately whether what they have done is positive or negative for them in the game, whether they are staying within or breaking the rules, moving closer to the goal or further away and how they are doing versus the competition; (d) they have structured designer-generated activities with linear gameplay which confront players

with a fixed sequence of challenges; and (e) they have a defined space and time which include any narrative or story elements in the game.

(b) The informal end of the axis focuses on the play-dimension of game play, such as unstructured, spontaneous and free act of play. These are “free-form” digital games that (a) have no set of rules pre-determined by the game designers or if there are rules they are informal and flexible and the player has freedom to use them or not; (b) exhibit no pre-defined goal but accommodate players’ goals that are entirely intrinsic and personal; (c) have no “winning plot”, as they are more open-ended; and (d) include nonlinear games which allow greater player freedom than linear games. In free-form games the players have more freedom to decide what to do, to set their own individual goals and determine their rules, path, scenario and plot. As there is no system of rules that defines a victory or a defeat, a gain or a loss, the players’ aim is not to win but rather to learn the game through exploration and discovery play. The players are the authors of the play and goals in digital games of this category, and this is the only decision made for the players by game designers.

In fact, the two extreme ends of the axis hardly ever exist in their pure forms: there is a tendency to establish rules and goals for free-form activities, just as there is a tendency to soften the strictness of formally structured games with elements of free-form games. Full freedom of choice is an illusion (Charles, 2009; Krzywinska, 2003)and players are not active but reactive (Arsenault, & Perron, 2009), just as the most common place for agency to occur are the structured activities of games (Murray, 1997). Thus, most of the games can be placed mostly around the middle of the axis between totally free-form activity and formally structured goal-driven activity.

2.3. Adventure Games

2.3.1 Definition of Adventure games

The analysis of the existing studies in the current bibliography shows that there are many definitions of adventure games available. So, the aim of this subsection is to create a new definition capable of explaining better what adventure games are and which fundamental features they have. With this definition in mind we can then decide if any digital game can be classified into the adventure games category.

But what should the definition to look like? The method we are applying here is to go through six previous definitions of adventure games (Table 1) and choose their similarities in order to come to a new definition.

There are probably more commonalities than differences in these definitions. It is noteworthy to mention that often the same concept is expressed in different ways. For example, when researchers mention "objects", “items” or “tools” they all describe the same thing: The means that a player can use in order to solve puzzle and overcome obstacles. This allows us to gather all the points of the definitions under six game features:

Table 1. Existing Definitions of Adventure Games

Author(s)	Definition
(Crawford, 1982)	[…] **the adventurer** must move through a **complex world**, accumulating **tools and booty** adequate for overcoming each **obstacle**, until finally the adventurer reaches the **treasure or goal**
(Herz, 1997)	[…] adventure games are about accumulating an **inventory of items** that are then used to **solve puzzles**
(Prensky, 2007)	[…] **find your way** around the **unknown world**, pick up **objects** and **solve puzzles**
(Rollings & Adams, 2006)	An adventure game is a video game in which **the player** assumes the role of protagonist in an **interactive story** driven by **exploration** and **puzzle-solving**
(Gros, 2007)	**The player** solves a number of **tests** in order to progress through a **virtual world**.
(Van Eck & Hung, 2010)	[...] a broad category of fantasy games in which **the player** has to overcome a series of **obstacles** to reach the final **goal** or **destination**.

- The player moves through a virtual, complex and unknown world (Crawford, 1982; Gros, 2007; Prensky, 2007).
- The player assumes the role of protagonist – hero of the game (Adams & Rollings, 2007; Crawford, 1982; Gros, 2007; Herz, 1997; Prensky, 2007).
- The player tries to reach a goal.
- The games are often based on puzzle-solving or overcoming obstacles through the player's interaction with the game (Adams & Rollings, 2007; Crawford, 1982; Gros, 2007; Herz, 1997; Prensky, 2007).
- The player finds various objects, items or tools that help him to solve puzzles (Crawford, 1982; Herz, 1997; Prensky, 2007).
- Particular emphasis is placed on exploration (Adams & Rollings, 2007; Prensky, 2007).

2.3.2 Game structure in adventure games

While many kinds of digital games can be used in education, adventure games are probably one of the most efficient genres, because they are discourse- and story-driven. In fact, these games are not primarily based on reflex challenges, but rather on stories and problem-solving within a narrative framework. Good adventure games are all about getting into the story, asking the right questions, understanding characters and connecting plot points.

In this line of thought, our research focuses on exploring whether the concepts of freeform and structured games can be found in an interesting way in adventure games. A free-form adventure game is primarily driven by a story that is affected to some degree by the player and non-linear exploration and discovery. Adventure games that focus on the play dimension of gameplay allow

players to walk around and explore the world of the game at their own pace, to learn about the place and gather information, which will inform their decisions later. A free-form adventure game gives plenty of choices where things can happen in any order and players make decisions and live with the consequences. A feature that differentiates free-form games from structured ones is that the provided choices are of different kind. The consequences of these choices have significance, change the game considerably, as well as, have real impact on what happens next, implementing Sid Meier's idea (as is cited by Falstein (2005) that "a great game is a series of interesting and meaningful choices made by a player in pursuit of a clear and compelling goal". In an interesting choice, no single option is clearly better than the other options, the options are not equally attractive, and the player must be able to make an informed choice. On the contrary, a structured adventure game is also driven by a story but the plot is pre-determined by the game designers. Structured adventure games have structured designer-generated activities with linear gameplay which confront players with a fixed sequence of challenges. At the same time, they also exhibit strictly-defined space and time which frame all narrative and story elements in the game. Structured games also provide choices to players, but these choices lead to the same end without affecting considerably the game story and creating the illusion of freedom of choice.

Fundamental to this discussion is the concept of episodes in adventure games. Frequently, adventure games are split into episodes (or chapters or levels). In some adventure games these episodes need to be completed in a linear way, whereas in others one or more nonlinear episode completion patterns are possible. This type of non-linear gameplay gives to designers control over the game plot, but at the same time allows players to have non-linear freedom within each part of the game. It should be noted that there are games where all choices, although giving different items or points, essentially lead to the same narrative result. On the other side, there are games where the choices, even early on, can affect the sets of subsequent options. So simply adding the freedom of individual episodes doesn't capture this overall freedom.

In linear adventures the access of episodes (or chapters) is predetermined. Furthermore, although each of the episodes can be internally non-linear, the episode sequence is unfolded one step at a time. In contrast, non-linear adventures allow players to have an increased perception of freedom while playing the game, give them the feeling of being in control of the plot, and have the potential to result in a stronger sense of immersion in the game.

In our view, the above concepts add an interesting dimension for investigating freedom of choice with a focus on adventure games as the game genre of reference.

2.4 The concept of freedom of choice

The idea that freedom of choice is primary factor for leading a good life is not a new one. Given this it is easy to understand the significance of freedom of choice to evaluate the kind of gameplay.

In the literature review there are two different ways of viewing freedom each of which has been explored by scholars over a long time. According to the first approach (Rommeswinkel, 2014), there is a "positive" view of freedom, focus on what a person can choose to do or achieve, rather than on the

absence of any particular type of restraint that prevents him or her from doing one thing or another; according to the second approach, there is a “negative” view of freedom focuses precisely on the absence of a class of restraints that one person may exercise over another, or indeed the state may exercise over individuals. It is clear that both approaches have much to offer for assessing the freedom of gameplay.

A digital game with freedom of choice allows players to choose which challenges they want to overcome or not. Challenges have multiple ways for players to overcome them. In free-form games players have the ability to choose the order in which they face challenges. In contrast, structured games offer unique solutions to challenges and confront players with a fixed sequence of challenges, players have to follow a single path to one objective and there are no alternate paths or methods for accomplishing this objective.

3. Measures of freedom of choice

In social, political and especially economics science there are many scholars and researchers who have been engaged extensively with the concept of freedom of choice and they have suggested various measurement model of freedom of an individual to make choices. In the body of literature review there are two different views concerning the measurement of freedom: According to the first, freedom cannot be measured (Berlin, 1976; Taylor, 1991); according to the second view, freedom can be measured (Carter, 1999; Carter, 1992; Steiner, 1994). The scholars endorsing the latter view hold that freedom is a quantitative rather than merely a qualitative attribute; hence, extensive measurement of freedom is possible. The importance of such a view lies on the fact that if this position is valid, then these measurement models, with the appropriate adjustments, can be adopted for the field of digital games.

At the following subsection it is provided an overview of three measurement models of freedom of choice: (a) the cardinality measurement model of freedom of choice (Beavis & Rowley, 1983; Pattanaik & Xu, 1990), (b) the social measurement model of freedom of choice (Carter, 1992; Steiner, 1994) and (c) the Kramer’s measurement model of freedom of choice (Kramer, 2005). Based on these models we measured the degree of freedom of the selected four adventure games. In many cases, these measurement models have various disadvantages due to the multidimensional nature of the concept of freedom of choice (D’Agata, 2009).

- Cardinality Freedom (F^{card})

The Cardinality measure is suggested by Beavis and Rowley (1983), Pattanaik and Xu (1990) and Arneson (1998). The cardinality conception of freedom of choice is very simple. A person’s degree of freedom of choice depends on the number of options in his choice set. The options contribute equally to freedom of choice just in virtue of being different options. Cardinality Freedom takes into account only the set of all free choices that a player can perform in the game. Assuming that Ach is the set of all available choices and Cch (a subset of A) is the set of all free choices that the player can make in the game, the measure of choices that the player is free to carry out would be obtained as

$$F^{card} = |Cch| \geq 0 \qquad (1)$$

where |X| denotes the cardinal number of a set X.

The cardinality conception of freedom of choice has been criticised as too simplistic of a representation for the concept of freedom of choice. Two explanations were put forward as to why the cardinality conception fails: (a) it does not take into account the differences among the options; and (b) it does not take the values of the options into consideration.

- Social Freedom (F^{soc})

The concept of Social Freedom is suggested by Steiner (1983, 1994) and Carter (1999; 1992). According to them the freedom of choice cannot be quantified only by the level of cardinality freedom (number of available free actions), but it must also take into account also the actions that the agent is able to carry out. Following Steiner's and Carter's approach, the social freedom of a game would take into account not only the set of all free choices available in the game, but also the set of all choices (free and unfree) that the player is able to make. Assuming that Cch is the set of all available choices and Tch (a subset of Cch) is the set of all free choices that the player is able to make, the measure of choices that the player is free to carry out would be obtained as

$$F^{soc} = |Tch| / |Cch| \leq 1 \qquad (2)$$

where |X| denotes the cardinal number of a set X.

Unlike cardinality freedom, it is clear that social freedom is a "bi-dimensional" attribute, being determined not only by the number of free actions (cardinality freedom), but also by the number of feasible actions.

Still, this measure of freedom does not allow to distinguish between different cases. For instance, assuming that a game G1 exhibits 10 choices out of which 5 (50%) are feasible free, whereas game G2 exhibits 100 choices out of which 50 (50%) are feasible free, both games would have a social freedom of 0.50, whereas G2 is clearly able to offer the player a more important number (10x) of feasible free choices. Therefore, a notion of freedom would be needed which would incorporate the sheer number of feasible free choices that are finally available to the player.

- Kramer's Freedom (F^{kram})

Matthew Kramer (Kramer, 2005) introduces a new measure of freedom of choice which is a mixture of Cardinality and Social Freedom. Kramer points out that by multiplying the value of cardinality freedom with the value of social freedom "we lay paramount emphasis on each person of conjunctively exercisable freedoms [i.e. cardinality freedom]" (2005). Kramer's freedom, like social freedom, does not take into account only the set of all available free choices, but also the set of all choices that a player is able to make in the game. Assuming that Cch is the set of all available choices and Tch (a subset of Cch) is the set of all free choices that the player is able to make, the measure of choices that the player is free to carry out would be obtained as

$$F^{kram} = |Tch| \times |Tch| / |Cch| \geq 0 \qquad (3)$$

where |X| denotes the cardinal number of a set X.

Kramer's thought and his rejection of Steiner's and Carter's measure can be better understood through the previous example. Kramer's freedom of game G1 would be computed as

$$F^{kram}(G1) = 5 \times 5 / 10 = 2.50 \quad (4)$$

whereas Kramer's freedom of game G2 would be computed as

$$F^{kram}(G2) = 50 \times 50 / 100 = 25.00 \quad (5)$$

from which follows that

$$F^{kram}(G2) > F^{kram}(G1) \quad (6)$$

in line with the fact that the second game (G2), presents the player with a much richer (10x) array of feasible free choices.

Since an adventure games is divided into episodes/levels from which the player is free to choose, we consider that the overall game is the sum of its episodes. Given that the measures Fcard, Fsoc and Fkram are used to adventure digital games, the set of all available choices (the set Ach in the above definitions), all free choices (the set Cch in the above definitions) and all feasible choices (the set Tch in the above definitions) are firstly measured for each episode/level and then they are added together to determine the final result.

4. Research Methodology

4.1 Relative Benchmarking Methodology

The evaluation process is based on the relative benchmarking methodology. Benchmarking is used to ensure the quality of a software or production in comparison to other (Said, Tikk, & Cremonesi, 2014). There are two types of benchmarking: the absolute and the relative benchmarking. Absolute Benchmarking is a quantitative method developed to understand how well a software is doing versus how well it could be doing. With absolute benchmarking we can quickly identify software's opportunities for improvement. On the other hand, relative benchmarking is a quantitative method developed to compare how well a software is doing versus other similar products in order to find the most suitable for a specific context (Said et al., 2014).

In an attempt to rank the games measured along the various metrics as below according to a cross-metric assessment of the freedom of choice that they offer, a relative benchmarking approach has been employed. The following steps were taken in order to proceed with this assessment method:

(a) for each metric, the game with the higher score assigned 3 points, the game with the immediately lower score 2, the game with the immediately lower score 1, and the game with the lowest score 0 points;

(b) the total relative benchmarking score for each game was calculated as a sum of all partial scores ranging from 0 to 12 (12 being the highest possible score in the case of comparing 4 games with relative scores from 0 to 3 along four different metrics).

4.2 Measures of freedom of choice used in the study

Firstly, based on the measures described above we conducted an assessment of a number of selected adventure games in order to place them on a continuum between free and structured form. This study has employed the three measures of freedom of choice described above, namely Cardinality Freedom (F^{card}), Social Freedom (F^{soc}) and Kramer's Freedom (F^{kram}).

Apart from these, one more measure was used, wishing to take into account the episodes into which adventure games are split. As described earlier in this paper, in some adventure games episodes are completed in a linear and in others in nonlinear sequence, allowing players to have linear or nonlinear access to each segment. The additional measure used, therefore, is

- Episode Choice Freedom (F^{epi})

Adventure games are divided into episodes/levels from which the player is free to choose only one, more than one, or any, depending on the structured or free-form plot of the game. Assuming that Aepi is the set of all available episodes/levels and Cepi (a subset of Aepi) is the set of all episodes/levels that the player is free to choose, the measure of choices that the player is free to carry out would be obtained as

$$F^{epi} = |C^{epi}| \times |C^{epi}| / |A^{epi}| > 0 \qquad (7)$$

where |X| denotes the cardinal number of a set X.

4.3. Digital games used in the research

This study aims at formalizing a concept of game structure, and be able to evaluate its presence/absence in different digital games; more specifically, the research aims at the formalization and, eventually, at the quantitative assessment of a concept of game structure in free-form and structured digital games and trying to arrive at typologies so that different digital games can be placed at various points on an axis between totally free-form activity and formally structured goal-driven activity. The freedom of a games and the nature of the choices that make it up are at the heart of the interest of this paper and the subjective assessment as to whether a game is considered free-form or not. Games that give room to many different player-generated gameplay paths may engage a player, while games that constrain players to follow a single path to one objective may disorient them.

Since there are numerous free-form and structures digital games the following set of criteria, which are thoroughly analyzed in 5.1 subsection of this paper, four digital adventure games with different characteristics and gameplay types were selected and used in this research: games with pre-designated goals and pre-designed gameplay paths, which according to their structural characteristics they can be placed at "formally structured" end of the axis between free and structured form: "Journey in the Land of Letters"[1] and "Smarty and the Treasure of Rednose"[2]; and games that, having no pre-designated goals, neither a single "winning plot", give room to many different player-generated gameplay paths and which according to their structural characteristics they can be placed at "free-form" end of the axis between free and structured form: "Lure of the Labyrinth"[3] and "Magic Potion"[4] (Christou, et al., 2009).

Table 2 shows the comparison of selected digital games used in the study in relation to their structural characteristics.

Table 2: Comparison of Selected Digital Games

Games	Journey in the Land of Letters	Lure of the Labyrinth	Magic Potion	Smarty and the Treasure of Rednose
Non linear gameplay		✓	✓	
Multiple solutions to the challenges		✓		
Free sequence of challenges		✓	✓	
Selection of challenges		✓	✓	

5. Research findings

5.1 Measurements of structural freedom of choice along different metrics

In the context of this research, free choices are defined in terms of six key characteristics: (a) choices that impact on the path that player can take, (b) choices that lead to nonlinear gameplay, (c) choices that allow multiple solutions to the challenges, (d) choices that allow players to choose which challenge to overcome, (e) choices that allow players to follow their pace and (f) choices that give control over the game character. All quantitative evaluations were conducted by the two authors. Working independently, evaluators played the adventure games with two rounds. First, they browsed a game in the first round to know its main goal and its mechanics and to see which features it has. Then they played the game in much more detail, and each session was video recorded with screen recorder. Then the evaluators watched again the recordings and tried to represent the gameplay flow and states on diagrammatic formalisms such as State Transition Diagrams, trying to visualize how players interact with the game system. Based on this procedure, the measurements of the selected adventure games along the various freedom of choice metrics are shown at the following table (Table 3).

Subsequently, for each metric, the game with the higher score assigned 3 points, the game with the immediately lower score 2, the game with the immediately lower score 1, and the game with the lowest score 0 points.

Table 3. Measurements of Freedom of Choice along Different Metrics

Games	F^{card}	F^{soc}	F^{kram}	F^{epi}
Journey in the Land of Letters	32	10/47=21%	100/47=2.1	4.00
Lure of the Labyrinth	43	43/45=95.5%	1849/45=41.1	6.00
Magic Potion	50	50/82=61%	2500/82=30.5	3.20
Smarty and the Treasure of Rednose	1	1/21=4.7%	1/21=0.05	0.00

Finally, the total relative benchmarking score for each game was calculated as a sum of all partial scores ranging from 0 to 12 (12 being the highest possible score in the case of comparing 4 games with relative scores from 0 to 3 along four different metrics). The results are presented in Table 4.

Table 4. Relative Benchmarking Scores for the Freedom of Choice of the Games Measured

Games	F^{card}	F^{soc}	F^{kram}	F^{epi}	Total
Journey in the Land of Letters	1	1	1	2	5
Lure of the Labyrinth	2	3	3	3	11
Magic Potion	3	2	2	1	8
Smarty and the Treasure of Rednose	0	0	0	0	0

This quantitative assessment of freedom of choice revealed that Lure of the Labyrinth had a higher total relative score (11 points) compared to other three games studied, providing an indication that it can be considered as the game which offers the higher freedom of choice of all four. Magic Potion scored lower (8 points) than Lure of the Labyrinth and higher than the remaining two games, so that it can be considered as offering an amount of freedom of choice fair for this game sample. Finally, Smarty and the Treasure of Rednose scored (0 point) behind Journey in the Land of Letters (5 points), and can thus be considered as the game of this sample with the least free plot and interaction.

In this line of thought, based on the above findings, the adventure games studied could be placed on an axis between those offering the lowest and those offering the highest freedom of choice as shown in Figure 1.

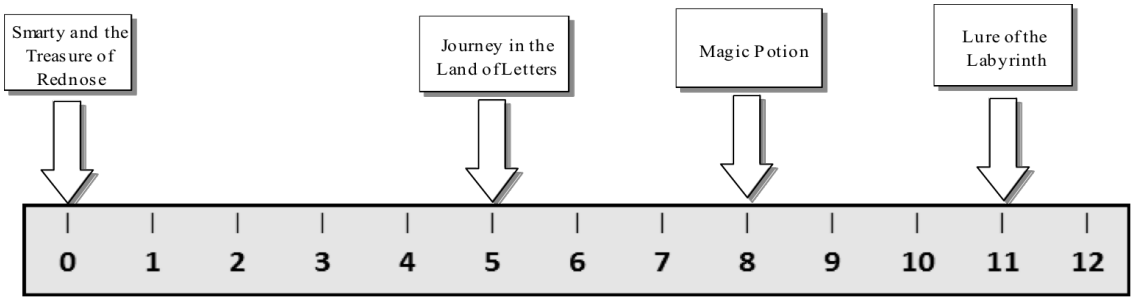

Figure 1. Ranking of Games According to Their Freedom of Choice Measurements

5.2 Impact of structural freedom of choice on dynamic freedom of agency

Finally, in order to cross-examine and appraise the indication that a high degree of structural freedom of choice ultimately leads to greater dynamic freedom of agency and, in general, gaming experience is positively valued by the players, we compared the quantitative assessment with a qualitative assessment of the same games based on the set of FoC heuristics in digital games based on the structural characteristics of digital games and the perceptions of students and/or teachers. The set of FoC heuristics, which is presented in Table 5, has been developed during the first steps of the project aiming at measurement of the concept of freedom of choice in adventure digital games and it is analytically presented in Kirginas & Gouscos (2016b).

Table 5: Set of Heuristics for the Assessment of Freedom of Choice in Digital Games

Number	Heuristic
Heuristic 1	The game gives players freedom of movement
Heuristic 2	The game allows players to follow different paths into the game
Heuristic 3	The game is paced in order to apply pressure but without frustrating the player
Heuristic4	The game gives the player control over the game character
Heuristic 5	The game has no winners or losers
Heuristic 6	The game story encourages immersion
Heuristic 7	The game supports multiple solutions to the challenges
Heuristic 8	The game allows players to choose the challenges that they want to overcome or not
Heuristic 9	The game allows players to choose the order in which they face challenges

In the context of this research heuristic evaluation was conducted by the two authors, without neglecting the benefit of an additional assessment based on the players' gaming experience. Working independently, evaluators took each heuristic one a time and rated the extent to which they agreed or disagreed with each of 9 items of FoC heuristics using a 5-point Likert scale (1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). To get a single score, the two evaluators averaged their scores for every game and every heuristic. The average ratings are shown in Table 6.

Table 6. Measurements of Freedom of Choice

Games	H1	H2	H3	H4	H5	H6	H7	H8	H9	Total qualitative assessment
Journey in the Land of Letters	2	2	5	1	2	1	1	2	3	19/45 = 0.42
Lure of the Labyrinth	3	4	5	1	1	2	3	4	4	27/45 = 0.60
Magic Potion	3	4	5	1	2	1	1	3	3	23/45 = 0.51
Smarty and the Treasure of Rednose	1	1	5	1	2	1	1	1	1	14/45 = 0.31

Such an evaluation constitutes a further research effort in order to establish a more integrated value-based approach for the evaluation of the concept of the freedom of choice. It should be noted that, in this pilot research, the proposed methodology is used as an assessment tool of selected adventure games, but at the same time the selected games (it is an indicative and not exhaustive selection of the available games) are used, indirectly, as a sample to test the appropriateness of the methodology itself.

To the extent that, as shown by the results below, the application of the methodology has led to the emergence of some important elements, is presumed the interest of the adopted methodological

approach, which can certainly be improved by involving more experts and/or players, further weighting of the results, as well as specialization in different categories of digital games.

This qualitative assessment of freedom of choice again revealed that Lure of the Labyrinth had a higher score (0.60) compared to other three games studied, indicating that it is the game which offers the higher freedom of choice of all four. Magic Potion scored lower (0.51) than Lure of the Labyrinth and higher than the remaining two games, so that it can be considered as offering an amount of freedom of choice fair for this game sample. Finally, Smarty and the Treasure of Rednose scored (0.31) behind Journey in the Land of Letters (0.42), and can thus be considered as the game of this sample with the least free plot and interaction.

Based on the above findings, the adventure games studied could be placed on an axis between those offering the lowest and those offering the highest freedom of choice as shown in Figure 2.

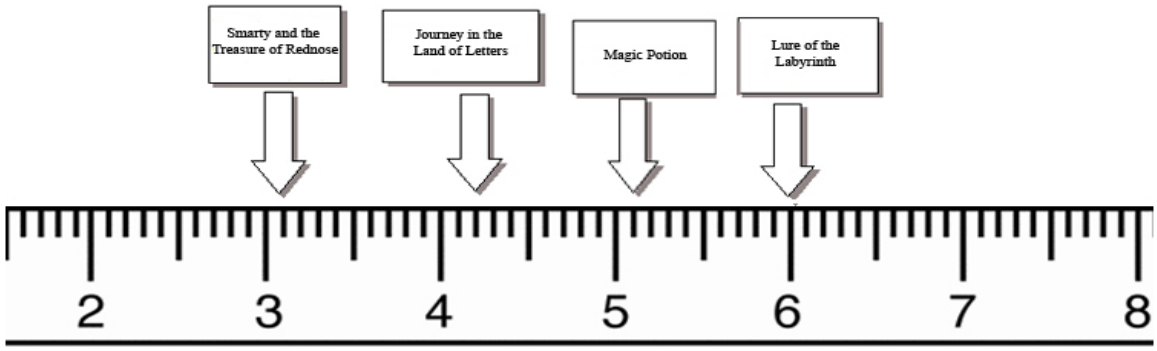

Figure 2. Ranking of Games According to Qualitative Assessment

The results from these quantitative assessments, as indicated in Figure 1, are in line with the qualitative assessment, as indicated in Figure 2, providing an indication that quantitative measurements of structural freedom of choice in adventure digital games can faithfully reflect their free-form or structured nature, as also reflected by qualitative structural characteristics-based assessments.

6. Concluding remarks and points for further research

Beginning with the assumption that freedom of choice can be measured (Carter, 1999; Carter, 1992; Steiner, 1994), we propose four models for the quantitative assessment of a concept of freedom of choice in free-form and structured digital games, in order to arrive at a typology that allows different digital games to be placed at various points on an axis between totally free-form activity and formally structured goal-driven activity The findings of this pilot approach, although covers only a part of the experience that emerges during Human – Computer Interaction (player – game interaction) which should be further investigated, strongly suggest that the measurement models described in this paper can be used to measure the structural freedom of choice in adventure games in order to characterize them as free-form or structured games.

In this respect, a quantitative approach, such as the one proposed in this paper, could be considered advantageous, in the sense that (a) it delivers assessments which are more clearly structured and can be better substantiated, (b) it is more objective than qualitative method based on data, and (c) needs little human resources in order to be implemented.

However, there are still issues that must be addressed, in order to fully measure the concept of freedom of choice:

Freedom of choice along games is not linear. That means that there are games where all choices, although giving different items or points, essentially lead to the same narrative result. On the other side, there are games where the choices, even early on, can affect the sets of subsequent options. So simply adding the freedom of individual episodes doesn't capture this overall freedom.

Mechanistic models for examining player experience are objective, low cost and can save time. However, there are some very complex and open-ended games with an enormous number of choices and hence it is difficult to be measured with qualitative methods.

The definition and interpretation of free choices in adventure digital games is a highly subjective issue, so it is important for all the involved game researchers to use a valid coding system, in order to map the concept of freedom of choice in their entirety.

The significance of the concept of structural freedom of choice is even greater, especially when we talk about digital games for learning purposes. Free-form digital adventure games, with their structural features, alter player experience and create a positive condition of attention and more receptivity for learning. Such games can lead to more engaging and more free-form learning processes and these latter processes may in turn be able to better support innovative approaches to learning and, more generally, to the acquisition of 21st century transferable skills (Kirginas, S., & Gouscos, 2016a; Kirginas, S., & Gouscos, 2016b; Kirginas & Gouscos, 2017). In the same line of thought, we speculate that digital games with freedom of play can be used across multiple learning subjects, put students at the centre and engage them actively in the learning process, promoting 21st century transferable skills such as discovery and experiential learning, collaboration, decision taking, active and critical thinking, creative thinking, problem solving skills. On these premises, school teachers and educators who want to encourage innovative learning processes could use free-form digital games in order to enrich their teaching methods and enhance students' learning.

On the other hand, the suggested measurement models face a couple of problems. The first difficulty concerns the measurement of "free" choices. Clearly, there is no guarantee that every choice in the game can be measured. The second problem concerns game with an enormous number of choices. There are games, like open-ended games, which have huge trees of moves that have never been mapped in their entirety. Of course, according to Wolf (2006), there is no need to map the entire tree of a game to get an overall sense of how its freedom of choice is structured.

Furthermore, the results are promising, but the study conducted has its limits: Firstly, a limited sample of four digital games had to be selected for this research from a large population of available free-form and structures adventure games. Secondly, the study was limited only to adventure games

and not to other genres of digital games. Thirdly, the characterization of choices with which students interact have be done by the authors of the paper based on the literature review, without considering students' perceptions and/or preferences. So does not allow for extensive generalization to be drawn from its results.

However, the work described in this paper is a good starting point for a larger project, including issues such as:

- a survey of selected games with the research question if there is a significant correlation between the level of freedom and students' preference, namely the more higher the level of freedom in a game, the more is students' preference about this game.

- a substantial direction of further research work has to do with the limits that freedom of choice has, as a factor for creating games that offer better experience and higher engagement. Should the objective of digital game design be to maximize freedom of choice at all costs? The exploration of the optimum level of freedom of choice seems, at this time, to be one of the most interesting directions of research that we would like to pursue.

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