

# A Proposal of Cognitive Classification of Electronic Games

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## Abstract

Indicative classification by age group appeared in order to warn up parents how audiovisual works could exercise training of children. Therefore, this classification has contributed to the electronic games industry, while reduced the stigma of marginalization that many authors have attributed to these applications. Likewise, this work presents a cognitive classification which would consolidate and enhance the benefits of gaming in society. We propose a classification for electronic games based on the cognitive processes described in the literature, trying to integrate the features of each game to the benefits provided by the practice.

**Keywords:** cognitive, classification, game, genre

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## 1. Introduction

The video game industry is one of the largest in the world and has entered into a process of expansion, exceeding the billion dollar movie industry in terms of revenue, according to the Electronic Magazine [Landim 2011]. Most people who play electronic games do simply for pleasure or as a way to pass the time. However they do not know the potential of such an act, for example, health benefits [Barthelemy 2009], the individual training [Grace 2005] and development of cognitive functions [Griffiths 2002].

According to [Romão et al. 2006], indicating the classification criteria are established based on research and debate, based on the Country's Federal Constitution and the Statute of Children and Adolescents. This article presents a proposal for classification of the main cognitive models based on the analysis of the genres of games.

Currently, cognitive processes can be classified into categories, according to Norman in 1993 (reviewed in [Preece et al. 2005; Passerino 1998]). Thus, we intend

to investigate whether and what links can be established between the processes cognitive and electronic games, to create a classification system.

This game classification can influence in a constructive way:

- In the choice of parents in a particular game for the child, enabling them to analyze whether it contributes to the development of certain cognitive area;
- In the gaming industry, which can be based on the cognitive benefits to improve the quality of its products;
- In psycho-pedagogical areas: selection of games to develop specific skills in the treatment of disorders of learning or psychomotor problems.

Thus, this proposal has enormous potential to the gaming market, with applications ranging from educational to therapeutic.

In [Hotz et al. 2012] researchers of the University of Rochester showed that players can focus on six tasks at once without losing focus, while people who do not have the habit of playing, can be focused on only four. In another study, also reviewed by [Hotz et al. 2012], researchers at the University of Michigan, which lasted three years and performed with 491 high school students, found that students who engage more computer games got the best performance on a standardized test of creativity, regardless of gender, race or the style of game played. This researches proves the seriousness of electronic games and show their relations with cognitive processes.

## 2. Electronic Games in Society

There is a wide range of studies based on electronic games and their impact on society, which in fact is essential for the development work, since this is mainly aimed to observe the changes and developments in human being caused by the use of multimedia system.

The act of playing has accompanied humanity since its inception. The games are part of everyday life and evolution [Machado et al. 2011]. The learning process of people becomes even better with the inclusion of multimedia in education. In [Gee 2003] a survey was

conducted and concluded that the appropriate use of multimedia instruction enhances learning performance of students in science, math and literacy.

A study by Stuart J. Menn in 1993 (reviewed in [Sztajnberg 2002]) shows that on the most effective methods of teaching, reading corresponds to 10% of learning, hearing corresponds to 20%, audiovisual information corresponds up to 30% and 50% comes from the observation of someone making while the action is explained and 90% of what is done, trained or simulated. These data demonstrate the efficiency and importance of games for learning.

Classification of products are important to society and also influence the consumer. A classic example are the traditional Nutritional Values, which are included on most food packaging industry, bringing tables of information on the amounts of vitamins, fats and proteins, among others, by serving and contributing to the daily needs. For example: when there is doubt on the part of consumers, between two similar products, it can analyze the nutritional information, which is more beneficial to your health.

However, one must take precautions about the overuse of video games, which can cause damage to other activities of the individual, for example, at school, where children and adolescents fail to do homework, as can be seen in the work of [Suzuki et al. 2009]. Second [Silva 1999], they may still fail to have an active social life because of video games, and this can be detrimental to intellectual development (academic and other functions important for their development would be set aside), physical, social, emotional and psychological. In addition to physical problems such as repetitive strain injury, obesity, eye problems (the child ends up getting very close to the television), and others. Nolan Bushnell demonstrated that "people should not exaggerate. I think two hours per day is the maximum" [Bushnell 2006].

### 3. Cognitive Processes

In this paper we assume that video games influence the cognitive process of the user. This session will discuss the limits and influence of each of these processes.

According to Norman in 1993 (reviewed in [Preece et al. 2005]) cognition can be understood as what happens in our mind when we perform our daily activities, such as thinking, remembering to learn, dress, make decisions, read, watch, talk and write. Preece makes a division of cognitive processes in attention, perception, memory, learning, communication, and reasoning. Part of this study is consolidated by [Matias and Greco 2010], and served as the foundation of our proposed classification of games.

The attention is important to focus concentration selection process elements, taking into account the time and the options available. It involves the hearing and / or visual senses. An example of auditory attention can be seen when we focus on one particular sound among many other sounds. The visual attention can be seen when we are looking for a specific word or phrase in a book. As we move our eyes when we see the text we know what we are looking for.

The perception refers to how information is acquired from the environment by different sensory organs (eyes, ears, fingers) and transformed into experiences with objects, events, sounds and gestures. In a game information must be clear, easily perceived, not requiring much effort from the user to understand what are the various components or objects within it.

The memory allows us to recall knowledge gained from our experience. This knowledge goes through an encoding that determines how information is accessed and how it is interpreted, depending on the extent of how it happens, will affect our ability to remember. An example would be when we see a movie, and the end of it we will be able to tell the whole story until a few details. Another example opposite the first is when we are in a church listening to a priest or pastor, to go out there do not remember almost nothing of what was said.

Learning is the way a person understands a given topic, and may use that knowledge in future applications. An example to note is when someone want to learn a new computer program; many people no longer use the manual. With this the author suggests that when the project can develop interfaces to support exploratory interaction, encouraging the user to use the components of the program and also allow some action to undo erroneous. It is also possible to limit the user releasing some functions and go as he is gaining experience. For example, when learning to ride a bike, usually begins with casters, making the apprentice do not worry about balance, focusing his attention on learning how to steer the bike.

Communication through reading, speaking and listening forms have similar properties, but also some differences:

- The written language is spoken is permanent and transient, we read a text several times, but we cannot do that with the spoken information.
- It is possible to read faster than listen, since it can use the dynamic reading which is not possible in spoken words in series;
- Listening requires less cognitive effort than reading or speaking;
- Written language tends to be more grammatical than the spoken;

Likewise, it is possible to exercise through games foreign languages. In a study by [Nascimento 2008] the author points out that in the act of playing the learner engages in communicative practices spontaneous and not induced by an instructor. The strategies and the use of mechanisms to achieve the goals are factors that contribute to the authentic use of foreign language, for it, the game is not only used as a simple training school but as a natural tool of communication.

Problem solving, planning, reasoning and decision making (mental process) are cognitive processes that involve cognitive reflective. It involves thinking and analyzing what to do and what decision to take by checking the available options. This process has a high value for the Design of Games, because it will influence directly the challenge. According to [Padovani 2008], decision making is the result of gathering information, which will give the perception, followed by assessment of the situation where he directs the attention concentration, then the selection of the available options are compared with information obtained and stored in memory and, finally, the monitoring results.

[Passerino 1998] conducted a detailed study relating cognitive processes memory (visual, auditory, kinesthetic), temporal and spatial orientation (in two and three dimensions), manual coordination (wide and thin), perception, auditory, visual perception (size, color, detail, shape, position, handedness, complementation), logical-mathematical, linguistic expression (oral and written), planning and organization as the main processes. This study confirmed many of the concepts defined by [Norman 1993; Preece et al. 2005].

#### **4. Relationship Between Electronic Games Genre and Cognitive Processes**

As what has been studied about the electronic games, their relations in society and in accordance with the proposed division of cognitive processes, the need arose for a division of electronic games, in order to obtain the parameters necessary to achieve the project objectives.

For this purpose we evaluated proposals from several authors [Foster and Mishra 2009], [Grace 2005] and [Gee 2003], which formed the basis for the formation of the current division at work.

James P. Gee in his work [Gee 2003], supports the need that when analyzing a video game we must separate its gameplay from its contents. In other words, we should not consider games just for its content but also the way this content is processed by the playability of the game.

According to [Foster and Mishra, 2009], organize games by genres is not a new idea. However, the goal is not merely classify different genres of games, but tries to connect these genres for the games in order to develop a systematic approach to the study and evaluation of these types of learning that can occur through the practice of different genres.

The definitions of each gender, which served as the basis for the study of cognitive classification, were made by: [Grace 2005], which defined the genre of action, adventure, puzzle, strategy, RPG and simulation; [Moyle and Janet 2002], which studied the gender education; [Pase and Tietzmann 2009] contextualized musical games; and [Greco and Benda 1998] and [Greco 2002] defined the genre of sport.

In order to formalize a relational profile between the genres of games to certain cognitive areas, this section investigates the parameters required for the proposed classification. This will be an indication of an association between genre and cognitive process, so not necessarily the genres mentioned are closely linked to co-related cognitive areas. We also emphasize that each genre includes numerous games, so games of the same gender can exercise cognitive processes distinct.

##### **4.1 Action Games**

The work [Green and Bavelier 2007], demonstrating that action games have been used to improve the performance behavior in a wide variety of perceptual tasks, which require effective allocation of attention over the visual scene, for requiring the successful identification of stimuli presented briefly.

According to [Green and Bavelier 2007] studies have been conducted in relation to a comparison of the attention resources of players and not players, where we observed an improvement in the spatial distribution of visual attention in the first group on the second. It was observed that those players could gain an advantage over others, especially in conflict situations. In establishing the causal role of gaming through training studies, the authors demonstrated that the action games increase the visual-spatial attention across the visual field.

##### **4.2 Action-Adventure Games**

According to [Elizabeth 2009], who conducted studies on the benefits of electronic games of action and action / adventure for cognitive development, was identified in a game of this genre the player differs from the characteristic that most of the time the character is in the third person, and in accordance with the characteristics of the digital environment it is encouraged to visual monitoring, with fast and accurate responses.

Given this premise was possible to observe the behavioral aspects of the players of this game genre,

and make him a relationship with the cognitive areas of attention, problem solving, reasoning and decision making, which features fans of the genre are more likely to develop according to the practice.

#### 4.3 Puzzle Games

According to [Kearney 2005] in their research demonstrated an improvement in the ability of spatial visualization in college students after six hours of puzzle genre game.

The work in [Dorval and Pepein 1986], states that students with spatial visualization skills tend to become good entrepreneurs and excel in subjects that involve math and science. In [Spense And Feng 2010], the authors report that games of this genre are more likely to affect spatial cognition. The fans are likely to exercise of memory, problem solving, planning, reasoning and decision making.

#### 4.4 Educational Games

Regarding educational games, the work of [Rebetez and Betrancourt 2007], have been demonstrated by research conducted field of psychology and cognitive science that investigated the effect of video games on users, indicating the development of skills such as attention, visual perception and learning, which are cognitive areas addressed in the project.

Both studies showed the growing perspective of games as not only a source of entertainment for children and adults, but also as an object of interest for academic research. What lies well to the idea developed in this project, since it is of great value to demonstrate the importance of studying the properties cognitive about the games.

#### 4.5 Music Games

When it comes to music games, it is possible to have two points of perspective on the subject: the first is the issue of perception of music, emphasizing cognitive aspects related to speaking, reading and hearing, whereas the second is the issue of coordination motor and visual manual (which is not treated in this work). Both points are treated, and as discussed in [Baily 1985], to prove the truth of the statements.

[Miranda 2010], highlights the possibility of using musical games in schools, demonstrating the importance of this genre of game as a leisure activity developed in school activities. Although the propositions of [Loureiro 2003], the music stands out as a key tool in education, which contributes to the formation of values and socialization.

Given the authors' assertions, it was possible to prove the relationship of perception and cognitive areas of speaking, reading, listening to this genre of game,

and it was still possible to observe the optical potential on the subject.

#### 4.6 Strategy Games

A familiar example of the strategy and problem solving, is given by George Polya that divides them into: understanding the problem, develop a plan for a solution, carry out the plan and look back to see what has been learned. [Polya 1945].

In a study by [Bayer and Renou 2011], in which they analyzed the relationship between cognitive and behavioral skills in strategic games due to an experiment in which users were submitted to this game genre was observed improvements in the results throughout the experiment, which resulted in a yield of 99%, which was proven in improving players' skills.

Based on the authors' assertions, we can observe the relationship between this kind of games and cognitive areas of problem solving, planning, reasoning and decision making.

#### 4.7 Role Playing Games

In the studies by [Rankin et al. 2006], the author mentioned that the RPG style games provide an infrastructure that allows players to form groups, so that social practices are emphasized. Another point mentioned is that the style of foreign languages encourages players to participate in related cultural practices will target language of the game.

According to the results demonstrated a 40% increase in vocabulary due to interactions with the characters. For intermediate and advanced students, we generated a 100% increase in the practice and interpretation of the characters talks. This study demonstrated the relationship of this kind of game with the cognitive areas of learning and practice of reading, speaking and writing.

#### 4.8 Simulation Games

With the aim to find traces of the use of skills and cognitive abilities, there is the analysis proposed by [Soeira 2011], who took the example of The Sims and raised the following hypothesis to guide research: "situations in the game require cognitive skills such as solving problems, make decisions and understand phenomena, and the creation of strategies."

The author also states that in the context of the game the player is involved in an atmosphere that will be asked to solve problems, and that means making decisions.

Another example that can be taken is the game called GOALS (Game Oriented Advanced Learning System) [Goes 1999], proposed with the objective to

train and empower entrepreneurs to make decisions quickly and accurately. The player is in an environment full of features close to the reality of the investment market, with which it interacts directly promoting its dynamics.

According to these studies, it was possible to observe the relationship of simulation games with the cognitive areas of learning, problem solving, planning, reasoning and decision making.

#### 4.9 Sports Games (with joystick)

According to the definition in [Greco 2002], in sports games (using the joystick) all actions are determined from the tactical point of view. In studies [Greco and Benda 1998], the authors say that the complete tactical capability consists of the interaction of cognitive processes, which provide the decision-making.

According to the authors in this genre of game is very important to know the uptake of information and decision-making, due to the fact the player to work with the unpredictable factors, randomness and variability, both by him as the opponent.

In sports such as volleyball, basketball, handball, futsal and football (the latter is regarded as one of the most famous among the electronic games of this genre), the cognitive component works in the process of response selection, so the player does reading the game.

According to studies [Garganta 2001], this kind of game the action of the player's success depends on its ability to adapt to the time and the construction of scoring possibilities (or goal). For this, we need decision-making in order to secure the position of the companions and adversaries. Examples: monitoring the trajectory of the ball, the movement to secure spaces and everything that is within the rules and according to specific technical and tactical behavior of each modality.

Finally, we may consider relevant in respect of some cognitive areas in the genre, such as attention, perception, problem solving, planning, reasoning and decision making.

### 5. Proposed Classification

From the study of cognitive processes and their relationship to the act of play, it is proposed a classification of cognitive games in a set of six groups (Figure 1), on the foundations of Norman in 1993 (reviewed in [Preece et al. 2005; Matias and Greco 2010]).

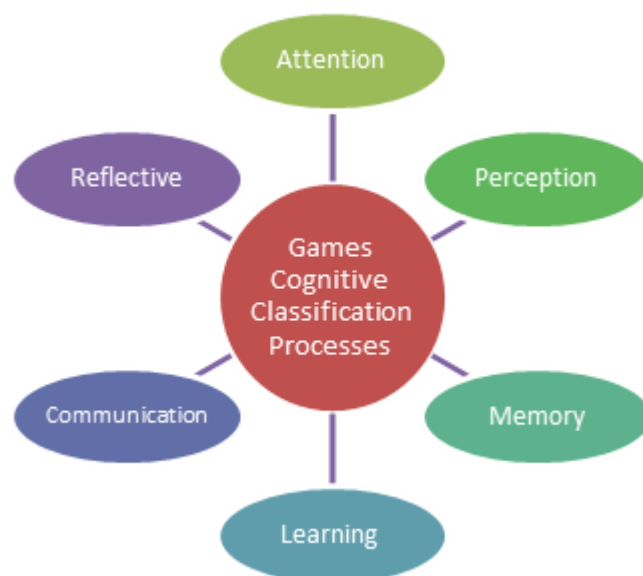


Figure 1: Proposal for classification of cognitive processes covered in electronic games.

Although a quantitative classification (level that a process is exercised in a given game) require deeper and more practical experiments, our studies specify the relationship between cognitive and electronic games, thus demonstrating the feasibility of deepening this classification. However, it is possible to identify some tendencies, which are reported below.

Reflective cognition, which is associated with problem solving, planning, reasoning and decision making, is more inclined to be addressed in most games, as well as being included in most genres in his work [Dorval and Pepein 1986] indicated that individuals with these skills tend to be good entrepreneurs and proficient in math and science subjects, due to the fact they can make quick decisions and accurate.

The area of cognitive attention tends to be exercised by the genres of action, action-adventure and education.

The improvement of the spatial distribution of visual attention and visual tracking are some of the supporters of these genres.

Perception has shown an inclination to be worked on action games, educational and musical. Development of a wide variety of perceptual tasks, such as visual perception and sound perception, are one of the highlights of these kinds of games.

The process of memory tends to be exercised in puzzle games in which recalled knowledge to evolve in the game represents one of the characteristics of the genre.

The cognition of learning is exercised by the players of RPG, simulation and educational games.

Many of these games explore pedagogy in learning, training and user training.

In turn, the cognitive abilities of communication (speaking, listening and reading) have shown a tendency to be exercised in musical genres and RPG. Perception of audio conversations and practices and interpretation of the characters are some of the features addressed by genres.

Finally, the reflective cognition is inclined to be worked in the genres of action-adventure, puzzle, strategy, simulation and sports. Problem solving, planning, reasoning and decision making justify classification of the genera mentioned.

## 6. Case Study

To illustrate the application of the Classification Cognitive proposal, there will be an investigation into the most famous game in the community of fans of the RPG genre [Crossley 2012], World of Warcraft (WoW). In this game, between the skills required of the user we can highlight the management of resources, creation of strategies for attack and defense, configuration and training of armies and communication between users.

According to the experiments performed by [Silva 2008], the cognitive processes exercised by this game are linked to the logical-mathematical thinking and teamwork. Justified by the fact that WoW players needed to constantly deal with various information about the game, to then make decisions.

In studies by [Laura et al. 2012], for some players, the World of Warcraft may provide more than just an opportunity for escapist adventure. This game is characterized by a cognitively challenging in a socially interactive environment that presents users with novel situations. Demonstrating, in their experiments, significant improvement in spatial ability and focus for participants. However, testing showed no change for participants on memory.

Given these findings, it is possible to realize the WoW inclined to exercise the following cognitive areas:

- Attention: by demanding the ability to handle spatial distribution and the focus and concentration to perform the tasks (confirmed by [Laura et al. 2012]);
- Communication: the exchange of information between users and interpretation tasks (confirmed by [Silva 2008]);
- Reflective: associated with the logical-mathematical thinking (confirmed by [Silva 2008]);
- Perception: we can infer that this skill is required because of the need for attention to

subtle changes in the map, armies of enemies and allies, the audible alerts, among other features.

Keeping within the same genre and mechanics of WoW, but adding more academic value to the game's plot (which is contextualized in historical situations), we can deepen the studies by [Arruda and Siman 2010] about Age of Empires (AoE). The authors found in their experiments, the user has not learned the history taught in school through the game, however worked with learning of reasoning and historical ideas that are fundamental to their understanding of historiography, to ensure their analytic stance forward to the past.

Thus, we can see that the AoE would receive the same classification of the previous game plus the classification:

- Learning: the academic context exercised (confirmed by [Laura et al. 2012]);

Therefore we conclude that, in relation to cognitive benefits, the game AoE exercises a wider range of processes than WoW. As this study just adds qualitative value to the application, we cannot yet consider the level of skill exercised in each of the cognitive processes identified. Thus, in this aspect, too early to make sure that the first is better than the second, as AoE would exercise more processes but in small quantities compared each with the same WoW.

## 6. Conclusion

Generally, the classification of products and services can guarantee increased sales and improved quality. Furthermore, in the context of electronic games, a cognitive classification could help in the decision consumer choice and treatment of learning disorders.

In this paper we reaffirm that the moderate use of electronic games can develop at least one cognitive process of the user. Thus, we propose a classification based on studies of [Norman 1993] and [Matias and Greco 2010] composed of processes: Attention, Perception, Memory, Learning, Communication and Reflective.

Through an extensive literature review we demonstrated that there is a relationship between genres of electronic games and certain cognitive processes.

Using two famous games (World of Warcraft and Age of Empires) of the RPG genre proved the possibility of making a qualitative comparison with the cognitive classification proposal.

## 7. Future Work

Aiming to fill some gaps that were not addressed in this article, came the need for a detailed study on the following items:

- Classification of video games by age group based on cognitive processes, which should be studied whether this classification is timeless and how it is subdivided.
- Classification related to physical activity: games that also work the physical part of the player, for example, technologies that allow interaction with the players of electronic games without the need to get your hands on a controller / joystick or keypad.
- Degree of stimulation: a comparative parameter set that addresses how each game genre is able to assist in the cognitive process.
- Features for a game to have as much cognitive qualities: what should be covered and how much a game, that he exercises the user's maximum cognitive qualities.
- Impact of cognitive classification of games in society: report of the consequences that a classification as this can have on society.
- Practical experiments and clinical evaluations: a solid show the veracity of this classification, with practical experiments and clinical evaluations.

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