Playability as Extension of Quality in Use in Video Games

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ABSTRACT
The quality of a software product is a main objective that every interactive system should aspire. There are many challenges to achieve this quality that require a previous characterization to ensure it. The International Standards Quality Models help to characterize the quality of a software system. But, there are some products that present 'special' quality requirements. In this paper we focus on special interactive systems: Video Games, whose quality requirements are different than traditional software. This additional dimension is called 'Playability'. In this paper, an extension of Quality in use Model for Playability decomposition (PQM) is introduced. In our playability quality model metrics are also considered and interpreted. Finally, we review different usability evaluation methods in order to identify what are the best evaluation methods for supporting playability evaluation tasks.

Categories and Subject Descriptors
H.1.2 [**Information Systems**]: User/Machine Systems - *Human factors*

General Terms
Design, Experimentation, Human Factors.

Keywords
Quality in Use, Interactive Systems, Video Games, Playability, Usability, User Experience.

1. INTRODUCTION
Nowadays, video games and entertainment systems collectively make up the biggest industry in terms of turnover, more so than music and cinema. We can deduce that videogames have become the preferred game of choice, exerting significant social and cultural influence over children, teens and adults [18]. As the quality of software has a direct bearing on product success and the User Experience, it should be taken into account throughout product development (hardware or software), so as to achieve the optimum experience for the player. The importance of video games in the actual society justifies the need to ask if the means of quality in this type of software is similar from the definition of the interactive or desktops software quality definition to guarantee an optimal User Experience.

In this work, we analyze how the game experience presents characteristics that are not explicitly in the quality standards models and why the usability or *quality in use* is not sufficient in video games context. We present a quality in use model for video games using playability to extend it for entertainment systems, with different attributes, facets and metrics to characterize the player experience with videogames.

2. THE QUALITY IN A SOFTWARE PRODUCT
When a *Desktop System* (DS) or Traditional Interactive System, such as a word processor, is developed, the main objective is that users can execute a set of tasks in a predetermined context, for example working in an office. The quality of this kind of systems has two main components: The first covers the functional aspects (functional utility) with two points of view: internally and externally. It has focused on disciplines such as Software Engineering. Another component indicates the means by which users can achieve this functionality. It is denominated *Usability* which has a great importance in HCI discipline. Usability represents a measure of product use whereby users achieve concrete objectives within a specific context of use.

Usability has been characterized in different international standards. ISO 9241-11:1998 [13] presents and define the Usability only as a characteristic of the process of use. In ISO 9226-1:2001[11] usability appears integrated in the properties of any software product. But, it is important to remark that the means of usability in the different standards models is not the same. In the first standard usability is: effectiveness, efficiency and satisfaction. But, in the second it is the easy of learning, understanding, operating and the attractiveness when use a software system.

These discrepancies between the standards are present in the following standards models. In ISO 9126-4: 2004 [12] appears the concept denominated *Quality in Use* whose definition is the same as the usability, but add the attribute of security.

Recently, ISO 25010:2009 [10] makes its contribution in this direction. The quality of a software system is described in terms of its elements and the interaction process. In this standard the Usability it is not one of the quality factor, it is an attribute of the Quality in Use with the flexibility and the security and they are associated to the interaction or process of use. Accepted recommendation in user interfaces design to improve the user experience can be found in [17, 22].

3. THE QUALITY IN VIDEO GAMES
The researches in HCI context have centred their objectives to study the user's abilities and cognitive process forgetting the emotional dimension. A new concept, which is called *User*

Experience (UX) [9], appears with this dimension. In entertainment systems it is only a partial vision of the reality, because it does not take into account all the quality attributes that influence the use of this 'special' interactive systems. These attributes identify the Player Experience (PX).

As we remarked previously, a videogame can be considered a 'special' interactive system, in that it is used for leisure purposes by users seeking fun and entertainment. Whereas the purpose of a desktop system is to execute a task, determined by a clear functional objective, our objectives when playing a videogame are more likely to be diverse and subjective. A videogame is not conceived for the user to deal with daily tasks, but rather it has a very specific objective: to make the player feel good when playing it. This objective is more subjective and personal than traditional software. Important recommendation for designing entertainment systems, based on this idea, can be found in [15, 21].

We propose that analyzing the quality of a videogame purely in terms of its Usability or Quality in Use is not sufficient – we need to consider not only functional values but also a set of specific non-functional values, given the properties of videogames. Additional factors to be considered might include, for example: rules of play; goals; storytelling techniques; virtual world recreation; character design, and so on. In other words, the PX could be much more complex than the UX. Hence we need to establish a set of attributes and properties to identify and measure the experience of players playing a videogame. These properties indicate to us whether a game is 'playable' or not – that is, they will identify the *Playability* of the video game. Later, we can use its properties to ensure the quality of a video game through a process led by playability goals to improve experience when players play the videogame, PX. In **Table 1** we present the differences between some goal to achieve in the design of an optimal User Experience and Player Experience [16].

Playability is a live topic in the scientific community; it has been studied from different points of view and with different objectives without consensus on its definition or the elements that characterise it. We have identified two specific strands of research: *Playability* as *only Usability* in video games context (understanding and control of the game system), and research based on particular elements of video games [5, 15]. In the second line of research, we find references to: *Playability* in the quality of game elements [16, 20]. There are few studies focused on defining *Playability* formally, [4, 14], but without specific reference to *Playability* attributes or properties to characterize it. *Playability* is based on Usability, but in the context of video games, goes much further. Furthermore, *Playability* is not limited to the degree of 'fun' or 'entertainment' experienced when playing a game. Although these are primary objectives, they are concepts so *subjective*. It entails to extend and complete formally the User Experience characteristics with *players' dimensions* using a broad set of attributes and properties in order to measure the *Player Experience*.

In previous works, González Sánchez et al [6, 7, 8] proposed the characterization of the Player Experience with a video game based on Playability (PM, Playability Model), showing which attributes and examples of their properties are needed to analyze the 'game experience'. They present a conceptual framework for analysis of player experience and its relationship with the most common elements that may form part of video game architecture.

Table 1. Different objectives between UX and PX Design

	UX Usability Goals: Productivity		**PX Playability Goals: Entertainment**
1.	Task completion	1.	Entertainment
2.	Eliminate errors	2.	Fun to beat obstacles
3.	External reward	3.	Intrinsic reward
4.	Outcome-based rewards	4.	Process is its own reward
5.	Intuitive	5.	New things to learn
6.	Reduce workload	6.	Increase workload
7.	Assumes technology need to be humanized	7.	Assumes humans need to be challenged

4. PLAYABILITY AS QUALITY OF GAME EXPERIENCE

To characterize the quality of game experience we will make use of a precise and complete analysis of Playability, attributes, and a conceptual framework to evaluate it in any video game, either from the viewpoint of the game as an interactive process or from the player who performed/plays with it [7, 8]. This characterization must be coherent with existed standard, especially the most recent because we understand that they are the most consensual and complete.

As we have remarked, the *quality of a software product* has two main points to be analyzed: the *quality of process* and the *quality of product*. We need to consider additional aspects related to the user experience/player, which are related to the emotional aspects of interaction with video games.

In [8] we defined Playability as:

'a set of properties that describe the Player Experience using a specific game system whose main objective is to provide enjoyment and entertainment, by being credible and satisfying, when the player plays alone or in company'.

It is important to emphasise the 'satisfying' and 'credible' dimensions. The former is more difficult to measure in video games than in desktop systems due to the high degree of subjectivity of non-functional objectives. Similarly, the latter depends on the degree to which players assimilate and become absorbed in the game during play – also difficult to measure objectively with traditional usability test. The Definition of Playability can be based on Quality in Use, but it should be added the above attributes. Also, the definition of particular properties or Quality in Use must be rewriting. For example 'Effectiveness' in a video game is not related to the speed with which a task can be completed, because typically a player will play for the maximum time possible, this being one of the game's main objective. With all of these considerations, Playability represents

'the degree in which specific player achieve specific game goals with effectiveness, efficiency, flexibility, security and, especially, satisfaction in a playable context of use.'

In Fig. 1 we present our *Playability Quality Model* (PQM) as an extension of the Quality in Use model ([2, 10]). It is focus on video games software applications. Next each quality factor and attribute in our quality model will be defined following the previously mentioned ISO standard.

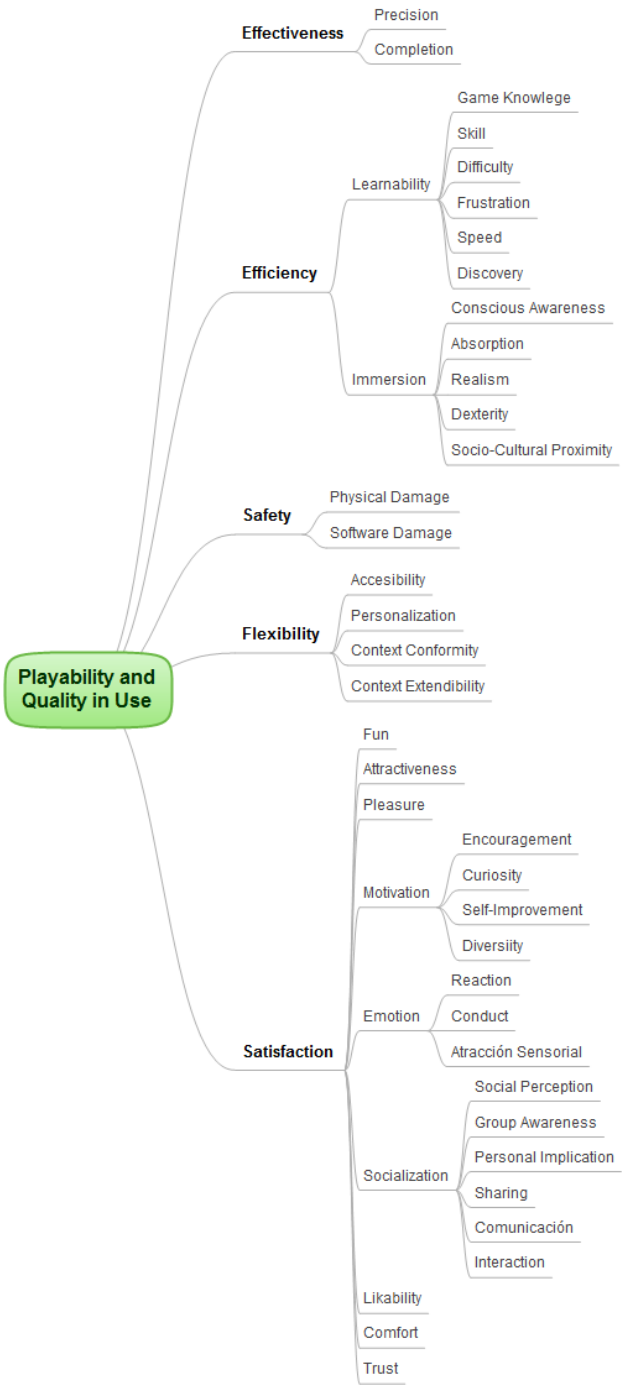

Fig. 1. Playability as extend of quality in use in video games

- ***Effectiveness:*** We define the degree to which specific users (players) can achieve the proposed goals with precision and completeness in the context of use, the video game.
- ***Efficiency:*** It is the degree to which specific users (players) can achieve the goals proposed by investing an appropriate amount of resources in relation to the effectiveness achieved in a context of use, the video game. This factor is determined by the ease of learning and immersion.
- ***Flexibility:*** It is the degree to which the video game can be used in different contexts or by different player or game profiles.
- ***Safety:*** It is acceptable level of risk to the player health or data in a context of use, the video game.
- ***Satisfaction:*** It is the degree to which users (players) are satisfied in a context of use, the video game. In this factor we consider various attributes such as fun, attractiveness, motivation, emotion or sociable.

Playability analysis is a very complex process due to the different perspectives that we can use to analyze the various parts of video game architecture. In this work, we propose a classification of these perspectives based on six *Facets of Playability* (PF). Each facet allows us to identify the different attributes and properties of *Playability* that are affected by the different elements of video game architecture [7]. The six *Facets of Playability* are:

- ***Intrinsic Playability*:** This is the *Playability* inherent in the nature of the videogame itself and how it is presented to the player. It is closely related to Game Core.
- ***Mechanical Playability*:** This is related to the quality of the videogame as a software system. It is associated to the Game Engine
- ***Interactive Playability*:** This is associated with player interaction and videogame user interface development. It is strongly connected to the Game Interface.
- ***Artistic Playability*:** This facet relates to the quality of the artistic and aesthetic rendering in the game elements (visual graphics, melodies, storyline and storytelling).
- ***Intrapersonal Playability*** or *Personal Playability*: This refers to the individual outlook, perceptions and feelings that the videogame produces in each placer and as such has a high subjective value.
- ***Interpersonal Playability*** or *Social Playability*: This refers to the feelings and perceptions of users, and the group awareness that arise when a game is played in company, be it in a competitive, cooperative or collaborative way.

The overall *Playability* of a videogame, then, is the sum total of values across all attributes in the different *Facets of Playability*. It is crucial to optimize *Playability* across the different facets in order to guarantee the best Player Experience.

5. PLAYABILITY AS MEASURE OF QUALITY IN A VIDEO GAME

We complete Quality in Use model based on Playability with the identification and association of metrics to the identified factors and attributes. To approach this task we use the international standards and we have adapted the different metrics and measures to evaluate and test video games.

The metrics, **Table 2**, have as objective the estimation of the quality of Player Experience with video games. Each column reflects the characterization of the different identified metrics. These characteristics are: the name of the metric, the objective that we analyze with it, its formula, the interpretation of the numerical value and the type of evaluation to estimate its value. We must to remark all the indentified metrics are focused in the use of the video game. Hence, the evaluation essentially requires test with players, observation to players when are playing and in

players' satisfaction case the realization of questionnaires when they complete the playtime.

Playability evaluation is related to evaluation of the user's performance and satisfaction when using the game, product or system in a real or simulated entertainment environment.

In this paper, see **Table 2**, we identified many relationships between playability and quality in use metrics, and we think that quality in use metrics are useful for playability evaluation. But some metrics should be interpreted in a different manner. For instance, if we have traditional software products, effectiveness metrics in international standards introduce *tasks effectiveness* or *task completion* as metrics. But when a game and playability is considered, we need to speak in terms of 'goals' in entertainment game context, as the challenges that the game introduced.

In a similar manner, *error frequency* metric in traditional software has sense, and a value closer to 0 is the better, but in games we propose *attempt frequency* as metric, and we can find values closer to 0 if expert players are playing, and closer to 1 if novice or clumsy players are considered. Normally, games introduce difficulties to capture and suck new players; a very simple game is not attractive, because it will be bored.

The *personalization* is an advisable factor in video games because in this software exists many design elements that try to distract, and to accompany the form of interaction. It should be flexible, for example supporting different interaction techniques: keys, pads, controls, menus, sounds and so on. The attribute of *accessibility*, however desirable and enforceable, traditionally has not enjoyed much attention in the development of video games. Nowadays this is changing and the presence of this attribute contributes to the use of it in the video game interface and mechanics.

Table 2. Metrics associated to playability attributes

	Metric name	Purpose	Formula	Interpretation	Evaluation method
Effectiveness	Goal effectiveness	What proportion of the goals is achieved correctly?	$M1 = \|1-\Sigma A_i\|$ A_i proportional value of each missing	M1 ∈ [0, 1], the closer to 1 the better	User test
	Goal completion	What proportion of the goals are completed?	X = A/B A = n. of goals completed B = total number of attempted goals	M1 ∈ [0, 1], the closer to 1 the better	User test
	Attempt frequency	What is the frequency of attempts?	X = A/T A = n. of attempts made by the player T = time or number of goals	Expert player closer to 0. At the beginning > 0	User test
Efficiency	Goal time	How long does it take to complete a goal?	$X = T_a$	Novice players will have more time	User test
	Goal efficiency	How efficient are the users?	X = M1/T	X ∈ [0, 1], closer to middle value	User test
	Relative user efficiency	How efficient is a player compared to an expert?	X = A/B A = ordinary player's goal efficiency B = expert player's goal efficiency	M1 ∈ [0, 1], the closer to 1 the better	User test
Flexibility	Accessibility	What proportion of the goals can be achieved by using alternative ways of interaction?	X = A/B A = goals with alternative interactions B = total number of goals	M1 ∈ [0, 1], the closer to 1 the better	User test
	Personalization	What proportion of the personalization options are used by the players?	X = A/B A = personalized elements B = elements in the game	M1 ∈ [0, 1], if closer to 1 original interaction way, perhaps should be changed	User test
Safety	User health and safety	What is the incidence of health problems among users of the product?	X = 1 – A / B A = number of players reporting errors B = total number of players	M1 ∈ [0, 1], the closer to 1 the better	User test
	Software damage	What is the incidence of software corruption?	X = 1 – A / B A = n. occurrences of soft. corruption B = total number of usage situations	M1 ∈ [0, 1], the closer to 1 the better	User test
Satisfaction	Satisfaction scale	How satisfied is the player?	X = A/B A = questionnaire producing psychometric scales B = population average	X>0 the larger the better	User test + questionnaires
	Satisfaction questionnaire	How satisfied is the user with specific software features?	$X = \Sigma A_i /n$ A_i= response to a question B = number of responses	Compare with previous values, or with population average	User test + questionnaires
	Discretionary usage	What proportion of potential users choose to use the system?	X = A/B A = number of times that specific software functions are used B = number of times players are intended to be used	M1 ∈ [0, 1], the closer to 1 the better	Observation of usage
	Socialization	What proportion of potential users choose to use the system?	X = A/B A = number of times that game is used in a collaborative environment B = number of times that game is used	M1 ∈ [0, 1], the closer to 1 collaborative game, closer to 0 personal game	Observation of usage

Accessibility is a quality attribute considered in the definition of quality in use. In our playability model proposal, that attribute is also considered. Accessibility problems can be considered to be usability problems for particular group of players e.g. those with disabilities. If a player cannot understand what is said in cut scenes or cannot hear the footsteps of someone sneaking up behind him or her, because the player suffers from an auditory disability or if the game does not support the use of specific input devices such as one handed controllers or sip and puff joysticks that allow severely physical disabled players to play the game.

The *safety* is an important factor nowadays in video games. The game process is not only a static and mental activity. In some cases, it demands physical requirements, for example game controls that demands and important corporal or physical effort and their effects can be sometimes potentially dangerous or not very recommendable to the player health if the player carries out this activity for a long time.

Satisfaction is the most important attribute in videogames due to different aspects can be considered in it: cognitive, emotional, physical, fun and social. The estimation of the degree of satisfaction in a video game is realized using questionnaires and observing the player during the game process and analyzing the user preferences in the different game sessions with video games. Probably, when games are considered the more important or determinant quality attribute is the achieved satisfaction rating. This attribute is subjective and in our playability quality model is enriched by using additional quality attributes and sub-attributes.

Thanks to proposed metrics, the quality model of the player experience with videogames based on playability, (PQM) is complete as [1] recommend for quality models developing.

In last column of **Table 2** different *playability* evaluation methods are suggested for each metric. These evaluation methods are the same that we use for usability evaluation. In the next section, we will discuss different evaluation methods; our main goal will be use these methods for playability evaluation purposes.

6. PLAYABILITY EVALUATION METHODS

This section reviews usability evaluation methods (UEMs) gathered in different reports from MAUSE project. MAUSE project was a COST Action, COST 294 from 2004 to 2009. The ultimate goal of MAUSE was to bring more science to bear on UEM development, evaluation, and comparison, aiming for results that can be transferred to industry and educators, thus leading to increased competitiveness of European industry and benefit to the public. In this paper, we are focused on another quality factor; playability and we want to discuss if UEM are useful as playability evaluation.

In COST 294, four major research and development activities were implemented by four working groups. Concretely, working group 1 did a critical review and analysis of individual UEMs. The primary goal of this activity was to build a refined, substantiated and consolidated knowledge-pool about usability evaluation, based on the expertise, experiences, and research works of the participating project partners. Different reports were written and [19] were used in this paper as input.

In order to evaluate previous proposed metrics and quality model we need to specific playability evaluation methods (PEMs). In [19] three categories of evaluation methods were gathered: Data gathering and modeling methods (DGMM), User Interactions evaluation methods (UIEM), Collaborative methods (CM) and Mixed methodologies (MM),

First group, DGMM, is used for gaining knowledge about users and their activities. Two subcategories were distinguished: Data gathering methods (DGM) and Modeling methods (MM). These evaluation methods are useful for playability evaluation, but not always. Surveys and questionnaires come from social sciences, where surveys are commonly used and questionnaires are methods for recording and collecting information. In this context, games can be used by many kinds of user, for instance preschool children; 2 to 5 years old, surveys and questionnaires useful because it is also for them to verbalize their options. Think-aloud protocol is not a solution, because even school children ages 6 to 10 years may have difficulty with concurrent thinking aloud and they cannot be left alone.

Modeling methods (MM) are often associated with specific data gathering methods or their combination. In this set of methods, an example is especially interesting, Personas [3]. It is a precise descriptive model of the user, what user whishes to achieve and why. But this method is more a User-Centered Design complement. We think that other techniques associated, such as ConcurTaskTrees (CTT) or K-Made, are not useful when playability is considered. Normally, games need very complex models, because they have many interaction freedom degrees; games and activities for entertainment are rich interactive applications, where users can do things in many different ways.

Table 3. Heuristics and principles for game designing

(Korhonen and Koivisto, 2006)	(Rouse, 2001)
1. Don't waste the player's time. 2. Prepare for interruptions. 3. Take other persons into account. 4. Follow standard conventions. 5. Provide gameplay help. 6. Differentiation between device UI and the game UI should be evident. 7. Use terms that are familiar to the player. 8. Status of the characters and the game should be clearly visible. 9. The Player should have clear goals. 10. Support a wide range of players and playing styles. 11. Don't encourage repetitive and boring tasks.	1. Consistent World. 2. Understand the Game-World's Bounds. 3. Reasonable Solutions to Work. 4. Direction. 5. Accomplish a Task Incrementally 6. Be Immersed. 7. Fail. 8. A Fair Chance. 9. Not Need to repeat themselves. 10. Not Get Hopelessly Stuck. 11. To Do, Not to Watch. 12. Do Not Know What They Want, But They Know It When They See It.

User Interaction Evaluation Methods (UIEM) are explicitly targeted towards evaluation. Knowledge-based and empirical methods are considered in this group. In these methods experts and experience is considered, but games are different from others kind of applications and heuristics or principles for them are not the same than Schneiderman [22] or Nielsen's principles [7]. In **Table 3** some meaningful heuristics for game designing are shown [9, 10].

We think that user testing, observation and data gathering are the best manner in order to playability evaluation. Many times these

user testing are done with children and we must to know that tests cannot be done with children younger than 18 without the permission and supervision of their parents. Questionnaires are useful tool for playability evaluation too, but sometimes cannot be used, because children are too much young.

7. CONCLUSIONS AND FUTURE WORK

The quality of a system is the result of the quality of the system elements and their interaction. But every software applications are not equal. In this paper, games and entertainment software are considered. In this context, playability is our main quality measure and we presented a playability quality model based on international standard and the interaction component of the quality is especially taken into account.

We identified a direct connection between quality in use and playability. Quality in use is a useful concept when interaction with traditional software is evaluated. But games are different in many aspects from others kinds of software. In this paper, meaningful differences between games and traditional software in the quality model, metrics, and principles or heuristics were identified. In our proposal, the main contributions in playability characterization are related with the player's satisfaction and ISO 25010 [10, 19] was enriched in order to evaluate the interaction with games. Our metrics are ISO 9126-4 [12] inspired, but in this paper different interpretation and additional metrics are presented.

Nevertheless, these metrics need to be used and validated by using real games and evaluations experiments, and, in this moment, we are doing several evaluations in order to validate the proposed metrics.

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