Building a Pervasive Social Gaming Experience using SocialPG

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Abstract Pervasive computing has become a key element to build applications that use fun as a motivating component because it allows exploring new interaction schemes by making the concept of space and time ambiguous and confusing. The present research describes a Pervasive Social Gaming experience, using as a reference SocialPG, which is a model that describes social expansion as a strategy to improve gaming experiences supported by pervasive computing. In this article a description of the model is offered, software architecture is proposed to support it and a case study related to the process of error resolution and detection of improvement opportunities in software products is developed, finally, a general idea about the final software product that will support the game experience is offered together with an evaluation performed by a set of users, where some important findings are highlighted, such as the importance of the missions as a unit of cooperative work and the spectator's participation.

Keywords: Pervasive Games, Social Gaming Experience, Pervasive Computing.

1. Introduction

The inclusion of game activities in the different areas of our lives is becoming increasingly important. At the technology level, Marczewski (Marczewski, Even Ninja Monkeys like to play, 2015) uses the term "Game thinking" to refer to the design of applications whose objective is to provide the user with new experiences and awaken different emotions and feelings, with the incorporation of fun user interfaces and mechanisms that involve game elements. It also describes the concept of the game-inspired application according to the degree of game elements they contain and the objectives for which they were designed, thus some applications have game-inspired user interfaces, gamified applications, and games at their best.

The theory of Game Thinking takes from psychology a wide range of knowledge that allows us to better understand the human mind and thus detect determining factors in the construction of lasting, motivating, and entertaining user experiences. The key is to build motivating user interfaces within a workspace where, in addition to promoting the execution of tasks, mechanics and dynamics are generated in parallel to maintain the level of motivation in the user over time.

Any system inspired by "Game Thinking" must take as a key factor in its design the fun exercised through the activity of "Playing". What stands out about Play is that it is an activity that brings fun and enjoyment. The philosopher Huizinga, in his book "Homo Ludens" (Huizinga, 1970), offers an important concept to analyze the process of playing, which he calls the Magic Circle.

The magic circle metaphor presented by Huizinga (Huizinga, 1970) is a voluntary and contractual structure that defines the space and time where the participant has fun and develops various

activities, mainly playing. Game designers can break these boundaries or expand them to reproduce a new generation of emotions.

Sometimes, the ambiguity of expanding the boundaries defined by Huizinga's magic circle is consciously exploited, so that a user is not sure what is fiction or reality in the game, nor the space where it takes place, and even does not know what his contribution or role is, all this represents an important opportunity to create new experiences and thus engage the user under the perception that any action or observation in his daily life can be seen as part of the game. Montola (Montola, 2009) defines those games that break this magic circle and states that "pervasive games are a genre of play that systematically breaks the boundaries of traditional play. The boundaries of the magic circle are explored in spatial, temporal, and social terms."

The expansion of Huizinga's circle can be translated to different realms of the play experience. At the spatial level, the place where the game takes place is confusing or limitless and the physical world is confused with the virtual space of the game. At the temporal level, there is the feeling that every moment of the person's life is connected to game action, it is not known with certainty when it begins and when it ends. And at a social level, it is related to involving people in the game experiences who are not traditionally part of the games, such as the audience (people who observe the game but do not actively participate in it), additionally, it is played with the level of awareness about the role played by the participant in the game and the possibilities of interaction that he/she has, among many other things.

Temporal expansion and spatial expansion have been enhanced by pervasive computing environments that provide technological devices with extensive levels of computing power, miniaturization, geolocation, and connectivity. A user can carry such devices with him without complications and can perform tasks of different nature and complexity. Nevelsteen (Nevelsteen, 2015) provides a valuable summary of several projects that include these technological aspects and how these advances impact the development of the user experience.

According to Avouris (Avouris, 2012), Geolocated games are a type of gaming experience, which have proliferated widely in recent years due to the increasing use of smartphones and the technical capabilities they possess, many of these games take place in different locations and extend over extended periods. Among the activities inherent in these games are moving to a specific location, inspecting artifacts, taking photos, recording videos and sounds. Avouris (Avouris, 2012) presents a comparative analysis of geolocated games based on the criteria of physical space, the average duration of the experience, technology used, history, and the objectives pursued, There he highlights how the experiences can be developed all the time in configurable spaces and with a story that serves to give context to the activities, among the games evaluated are Savannah, FeedingYoshi, Mobilegame, UncleRoy, Camelot, CitiTag, Relive the Revolution (RTR), CityExplorer, Hitchers, Mogi, Jindeo, Riot! , Frequency1550, MobileHunters and AlienRevolt.

Some other examples of geolocated games that use the technological advances provided by pervasive computing are, CATS (Magerkurth, 2004), Team Exploration (Gentes, 2010), FinN (Akribopoulos, 2009), Why Is Everyone Inside Me?! (Sanneblad, 2004), Geolympus (Arango-López J. F., 2021), LAGARTO (Maia, 2017), SPLASH (Razikin, 2011) and SoundPark (Pellerin, 2009).

The study published by Statista (Statista, Mobile Gaming Market Worldwide, 2021) recognizes the opportunities that mobile games represent, the increase in the power of consoles and mobile devices will allow better levels of quality and physics of games, 4K graphic resolutions will be a

standard, HDR rendering and realistic gaming machines will provide a more immersive experience. In 2021 the Video Games market was close to US$155.5 Billion and represents 52.9% of the digital media market, it is by far the largest segment in the area and is expected to grow at an annual rate of 9% until 2026.

Mobile Games are the fastest-growing segment within Video Games, this is primarily due to the high performance of smartphones and tablets, which allows the execution of applications with high levels of computation. Games and some modern devices rely on graphics processing units to work at very similar levels to computers and consoles. According to Statista, Augmented Reality is a technological option that will have a lot of use in mobile games after the success and popularity of the Pokemon Go game (Paavilainen, 2017).

Another aspect of interest concerning mobile games is that users are increasingly using their free time to engage in short, intense gaming experiences that have a large social component (McCauley, 2017).

Gamification is another concept related to Game Thinking that has gained much popularity and interest, Klevers (Klevers, 2015) highlights gamification as a way of incorporating game elements in a traditionally non-gaming context, to create a more favorable and motivating climate towards the development of the assigned tasks. Werbach (Hunter, 2012) describes several cases of gamification application, in the area of software development, marketing, sales, and health, and reports the results obtained through the presentation of different performance indicators, demonstrating the benefits derived from this strategy. Deterding (Deterding, 2011) performs an analysis to establish the necessary elements to obtain a gamified process, avatars, three-dimensional environment, narrative context, feedback, reputation, position, levels, economy, and exchange market, also citing the importance of teamwork and socialization.

The TalentLMS study (TalentLMS, 2019) conducted in the United States on a sample of 526 employees from various companies, yields important findings of the perception that employees have about the use of gamification in organizations, most of them consider that this type of strategy can help them in their productivity, additionally, the work exposes the main areas where gamification is exploited, that is, in learning, customer service, human resources, document management, collaborative work, etc.

The social aspect of a game experience refers to the interaction of participants, through individual or group actions, within the framework of mechanics designed to achieve specific objectives. Communication, collaboration, and competition are some of the most common mechanisms used to implement it.

MMO games are a type of social gaming experience of very wide diffusion, in which a group of players interact with each other and simultaneously share the same game world, taking advantage of the connectivity benefits offered by the Internet (Barnett, 2010). A fictional story is presented, where each player has an avatar that serves to interact with the rest of the participants. Parallel to the game, socialization activities are carried out, which in some cases extend outside the game, events and meetings are organized where communities of players converge to share strategies and knowledge. Some of these experiences are developed on mobile devices and make use of geolocation services to execute activities delimited by an actual physical space (Laato, 2019).

Socially expanded games depend on temporal and spatial expansion. Montola (Montola, 2009) warns that games that do not break the barrier provided by the area and the game session will hardly break the social barrier. This implies that the pervasive social game experiences that are

the subject of this research will require spatial and temporal expansion that are supported by pervasive computing technologies.

In the specific case of socially expansive games, there are some interesting case studies, Montola (Montola, 2009) for example gives great importance to the role played by the spectator and the degree of awareness he/she has about his/her role and the impact on the game mechanics prepared. In this way, the spectator can become an obstacle for the player, a witness of a game event, the receiver of a message or an object to be collected by the participating players.

The social expansion of the game is also related to the incorporation of strategies and elements to change the state of consciousness of the participant, that is, to control the perception of the participant about his role or objective within the experience, using motivating factors such as curiosity, mechanics are constructed in which players and spectators work together to achieve the objectives of the game defined by the designer.

According to Statista (Statista, Statista dossier on Twitch, 2021), the live transmission of video games is an activity of social interaction that takes place through various streaming platforms, such as Twitch and Youtube Game, is a very popular phenomenon among young people, video game manufacturers look very carefully at this trend and work on promoting their products through the most popular streamers, likewise, they see positively the incorporation of the viewer, as it represents an opportunity to create different types of interaction with players and thus achieve a different gaming experience.

Data shows that viewers (Statista, Statista dossier about live streaming, 2022) tend to spend more hours each year watching stored or live streamed games on specific channels, it is expected that traffic to these streaming portals will grow steadily until 2026, most users who use these services are in the age range between 20 - 39 years, and a large number of users make some kind of payment to use this type of service, either through a subscription or donation.

Viewer participation in Streaming platforms, according to Seering (Seering, 2017), offers opportunities to explore game features such as transient participation, simultaneous mass participation, and improvisation likewise presents new challenges for design. Seering also exposes a set of motivating factors that serve to explain the popularity that this type of tool has acquired, among these are the need to help the player, to change the current course of the game, to learn, to obtain a benefit from the observation or simply to annoy players or other viewers.

The participation of viewers in gaming experiences is a growing phenomenon that has aroused much interest in the community, this is manifested through a growing number of people who spend time watching video game broadcasts either in real-time or offline, hence it is presumed that there are a set of attractions and motivators related to this activity that should be taken into account when designing some kind of gaming experience, to take advantage of its benefits and use new elements that make the experience more attractive.

Findings found by Arango-Lopez (Arango-López J. C., 2017) demonstrate the absence of formal work methodologies specially designed to build pervasive games or software engineering artifacts that support their design. Likewise, Viana (Viana, 2014) reinforces this idea indicating that it is a fertile field of research that presents many challenges and that as a line of research it is in frank ascent and interest, likewise, the sustained and constant evolution of pervasive computing supposes important effort to create methods that allow adapting Pervasive Games to these advances.

There are different proposals to approach the process of conceptualization, analysis, and design of Pervasive Games, as well as methodologies to control their construction process. TEMPs (Guo, 2010) for example, establishes a conceptual framework based on a set of dimensions that serve as a basis to explain how the game world merges with the real world, Valente (Valente L. &., 2014) (Valente L. F., 2017) proposes some strategies to specify functional requirements by extension in Cockburn's use case specification template (Cockburn, 2000), as well as a quality model based on the attributes Spatiality, Permanence, Communicability, Accessibility, Sociality, Resilience, Context-Awareness, Aparicio (Aparicio, 2016) proposes a method for the construction of Gamified Processes integrating Goals and Game Mechanics while developing a continuous improvement process that allows evaluating its effectiveness, other initiatives (Ferreira, 2017) (González García, 2019) more automated suggest that the construction of a pervasive game experience starts from the design of a DSL (Domain-Specific Language) and with MDE (Model Driven Engineer) tools can be transformed into a tangible software product. As a general process to build Geolocated Games Arango-Lopez (Arango-López J. V., 2020) proposes GeoPGD, which is an integrated working model based on phases to develop geolocated pervasive game experiences, emphasizing narrative management and GamePlay related aspects, such as dynamics and game world.

In a documentary review of proposals for the design and construction of applications related to "Game Thinking", pervasive computing plays a central role, it is essential to ensure that game mechanics are developed sensitive to the real physical space and that they are prolonged for an indefinite period, as well, these technological advances offer the necessary guarantees to support communication and socialization between players, other roles such as The Spectator have been incorporated with a parallel and isolated activity to the evolution of the game, in this way, there are some points of interaction between Players and Spectators that allow activating some game mechanics.

In a game experience with social expansion, the Spectator should play a more active role in the achievement of the goals proposed by the designer, their contributions should help in a more decisive way to achieve them, likewise, the management of awareness about the role and goals of the participants can be translated into motivating factors that lead them to perform the proposed tasks.

The possibilities for innovation related to social expansion are very broad, incorporating new elements related to the social dimension can help to produce game mechanics that ultimately keep the participant engaged. That said, it is very important to understand the elements that make possible the development of a game experience with social expansion and then create a framework that serves to understand the structure that a socially pervasive game experiences and the challenges that the designer must face. The construction of this model should start from the following premises:

- Pervasive computing is the technological foundation. It takes advantage of geolocation functionalities, cameras, movement, sensors, actuators, multimedia resources of different nature.
- The resulting experience can be integrated with the physical world.
- There is a new role, the spectator.

To address social expansion Valera-Aranguren proposes SocialPG (Valera-Aranguren, 2021). This is a conceptual model that is based on the definition of pervasive social experience and can be used in the initial stages of design as a framework to understand the components needed to

build such an experience. SocialPG offers details on the incorporation of a new role, the spectator, which introduces an important element for the construction of game mechanics that involve non-traditional elements of interaction.

The present research describes the construction of a pervasive social game experience using the SocialPG model as a reference. For this purpose, the process of error management and construction of improvement opportunities in software products was selected, due to its social nature and the possibility of incorporating additional roles on which the social expansion of game experiences can be applied. In this paper, SocialPG is described in general, and architecture is proposed to support the components defined in SocialPG, the correspondence of the conceptual elements of SocialPG with the selected case study is made, a prototype is presented that evidence through a set of game mechanics a pervasive social game experience, finally, an evaluation process is presented to a set of users to determine opinions about different aspects of the game experience.

This article is structured as follows: Section 2 exposes the components of a pervasive social game experience, section 3 offers generalities about other models and methodologies to study and build PG, section 4 describes the SocialPG model as a proposal to analyze PG in the initial stages of game design, section 5 sets out a reference architecture that supports the proposed model, section 6 shows the application of the model in a particular case study, section 7 shows a prototype where a pervasive social game experience supported in SocialPG is shown, section 8 presents an evaluation performed by a set of users on the obtained software product, finally section 9 exposes future work and conclusions.

2. Components of a Pervasive Social Gaming Experiences

There is no consensus to define a PG, however, what stands out in all the definitions found is that it promotes a different game experience to that offered by a traditional game, mainly because the game develops alongside the player's daily life, breaks the social and physical limits of traditional games (Caon, 2013), promotes new experiences through its opposition to the rules within the environment where they are developed (Linehan, 2013) and generates a greater motivation than that obtained by traditional games (Åhlén, 2014).

One of the major problems when analyzing PGs is that the concept of pervasiveness can be used for many types of experiences (live role-playing games, geolocalized games,...). To solve this problem, we will start from the work that has been carried out in the GEDES research group of the University of Granada related to the conceptualization and characterization of the pervasive game (Arango, 2018) that have been carried out within the research project entitled DISPERSA (Design of Pervasive Games Based on Context-Sensitive Learning Experiences) where the problem of the development of geolocalized pervasive game experiences is addressed, In this sense, a definition of PG is proposed from the perspective of the user experience, describing how a PG involves the user in-game dynamics whose space expands according to the context where it takes place. This makes it possible to break the limits of the game world, making reality part of it, and the elements that compose it influence the development of the game.

Grace (Grace, 2019) states that a game experience is built on a set of objectives that are achievable through a set agenda, one that is known from the beginning by the participant or progressively revealed as the experience progresses, in this journey includes a set of meanings that serve to confront a conflict that Grace has called "The Obstacle", which in turn, becomes the reason to have fun and stay engaged. Grace, states that the minimum structure for a play experience

specification document should have at least two fundamental elements, objectives, and the way to achieve these objectives.

Within a formal game design scheme, the MDA framework (Hunicke, 2004) constitutes an important reference as it defines game mechanics as actions, behaviors, and control mechanisms provided to the player within a game context, also as suggested by Egenfeldt-Nielsen (Egenfeldt-Nielsen, 2013) and Järvinen (Järvinen, 2008), they function as meanings that direct the player in a predictable behavior to obtain the proposed objectives.

An interesting aspect of the mechanics is that, as Fernandez Vara (Fernández-Vara, 2019) points out, referring to Sicart (Sicart, 2008), they can be intertwined and form diverse interaction schemes, and at the same time they can be invoked by agents, with this term referring to any entity that acts on the game world.

The game world, as Adams (Adams, 2014) puts it, is an artificial universe, an imaginary place in which game events occur. It is composed of interaction-sensitive real objects and virtual objects, together representing the physical or virtual space, or both, where game mechanics involving players and spectators take place. The functioning of the game world and the objects that integrate it are supported by a set of related technological elements, connectivity, miniaturization, and computing power, which once deployed in a physical space serve as intermediaries between the participant and the real world.

Schell (Schell, 2019) defines the story as a narrative framework where there are characters with specific objectives and a set of obstacles interposed so that with varying levels of effort they can achieve them, the conflict to be resolved through individual or group actions in a game world contextualized in a specific time or place. Lopez-Arcos (López-Arcos, 2014) suggests that the Story is an essential component to maintain motivation and to direct the development of the activities of the Game experience, the appearance, and presentation of the objects of the game world is inspired by the concepts described in it.

Social gaming experiences can be developed in two ways, Emmerich (Emmerich, 2013) indicates that participants can create teams and compete with others, or they can work together to pursue specific goals.

According to the role they play in achieving the objectives defined by the designer, the participants can be divided into players and spectators, the players are more involved in jumping over the obstacles and solving the artificial conflict posed by the designer, the spectators have other interests, and their participation is more related to the interaction with the player and to support him in achieving the objectives. The spectator's rules of participation may be very different from those governing the player's interaction. Socially expanded games depend on temporal and spatial expansion. Montola (Montola, 2009) warns that games that do not break the barrier provided by the area and the game session will hardly break the social barrier. This implies that the socially pervasive game experiences that are the subject of this research will require spatial and temporal expansion supported by pervasive computing technologies.

In the specific case of games with social expansion, there are some interesting case studies, Montola for example gives great importance to the role played by the spectator and the degree of awareness he/she has about him/her and the impact on the game mechanics prepared. In this way, the spectator may become an obstacle for the player, a witness of a game event, the receiver of a message or an object to be collected by the participating players.

Considering the definitions related to PG and other concepts used to describe a game experience in general, a set of characteristics that serve to understand the components of a pervasive social game experience are proposed and used as a conceptual basis to formulate SocialPG (Valera-Aranguren, 2021), that is:

- The game experience is carried out in an integrated manner with the real world. The framework of space and time in which it is developed is ambiguous, so the experience can be developed in an open space and in a continuous way for the participant;
- There is a set of objectives that must be covered by the people who participate in the game; these are achieved through the execution of a set of activities arranged in the form of game mechanics;
- The game world, which is the artificial universe where game events occur, is composed of real objects that are sensitive to interaction and virtual objects and is where game mechanics are developed;
- The narrative framework defined by the story is an essential component to maintain motivation and to direct the development of the activities of the game experience;
- Participants are divided into two groups, players and spectators;
- The social dimension of the experience is associated with collaboration and competition among the participants, for which they organize themselves using different schemes. Different levels of awareness can be managed for the participants in terms of what they can do, what their purpose in the experience is, and who else participates.

3. Proposals for the analysis and construction of Pervasive Games

There are different proposals concerning the design and construction of pervasive game experiences that highlight some aspects to consider within the definition of SocialPG, it seeks to consolidate in a single proposal everything necessary for the construction of any application based on "Game Thinking" that takes advantage of the benefits offered by pervasive computing and supports social expansion as an attraction to generate other types of game mechanics. Among the aspects to consider are the attributes that describe a pervasive game experience (Valente, 2017), the factors that enhance it (Guo, 2010), how functional requirements are specified (Valente, 2014), recommendations to guide the construction process, incorporating goal orientation (Aparicio, 2016) and narrative (Arango-Lopez, 2020).

The TEMPs model refers to four dimensions that contribute to the game world merging with the real world. Perceptibility, which refers to different meanings that can be used to integrate physical aspects of the real world into the experience, so that a person can play physically through a specific action in the game world and feel its consequences in the same way as he/she perceives the real world, Sociability, which integrates the social aspects so that the player can develop different forms of interaction with similar others, in the same way as he/she does in the real world. Temporality and Mobility are related to the dimensions of time and space so that the game occurs anywhere and at any time.

Regarding design and its role as a key activity in the process of developing game experiences adjusted to the needs of users, there are proposals to specify and manage functional and non-functional requirements, in this sense, Valente (Valente L. &., 2014) proposes to make an extension in Cockburn's use case specification template (Cockburn, 2000) to incorporate attributes inherent to the operation of pervasive games (Primary Actor, Secondary Actor, Level, Inputs, Outputs, Smart Objects Used, among others), likewise (Valente L. F., 2017), describes a

quality model to evaluate the Non-Functional requirements associated with the pervasiveness of games (Spatiality, Permanence, Communicability, Accessibility, Sociality, Resilience, Context-Awareness).

For the construction of gamified processes, Aparicio's proposal (Aparicio, 2016) revolves around the definition of a structure of objectives, in this way, the designer performs a needs analysis, establishes a set of objectives, and includes the game mechanics that will serve to achieve them, a continuous process of evaluation is performed by capturing performance indicators, with which decisions are made for adjustments or improvements.

GeoPGD (Arango-López J. V., 2020) is a methodology for the development of PG that exposes a cyclical process formed by four main phases, Evolution of the Pervasive Narrative, in which they define the objects, characters, and other components of the story that will be told in the development of the game experience, Game World, which is the phase where the environment where the game experience will take place is defined, Game Rules, which establishes the rules and norms that will limit the player's actions, and Pervasive Dynamics, which focuses on the user's interaction with the experience, that is, different behaviors for the same scenario depending on the player's work environment.

4. SocialPG, a Model for the Construction of Pervasive Social Experiences

The conceptual model considers that any experience produced in game-inspired applications starts with the definition of a set of objectives and the corresponding mechanics to achieve them. There is a thread (narrative) centered on a historical period, a script with a world populated by fictitious characters and other imaginative elements, to direct the unfolding of the interaction and the activities of the participants, so that everything takes place in a game world that is directed by pervasive computing technology, it can be in a real world geolocated with the presence of sensors, a virtual world created by technologies such as virtual reality or augmented reality or a mixture of both. Participants communicate, work in teams or individually to execute collaborative or competitive processes that contribute to the achievement of the designed objectives.

The model consists of three layers, superimposed one on top of the other, in such a way that the services of one layer are exposed as specific functionalities to the layer immediately above, in this way, the lower layer called "Pervasive Computing and Application Integration" represents all the technological elements that support the construction of the "Game World" which in turn offers the necessary services for "The Participants" to interact on it. In this last layer, different types of interaction occur, between players, between spectators, and between players and spectators. The "Objectives, Mechanics and Game Components" and "The Narrative" are layers that inspire the design of the game world, all the activities of the overlapping layers are driven by the rules and definitions formulated here. (See **FIGURE 1**)

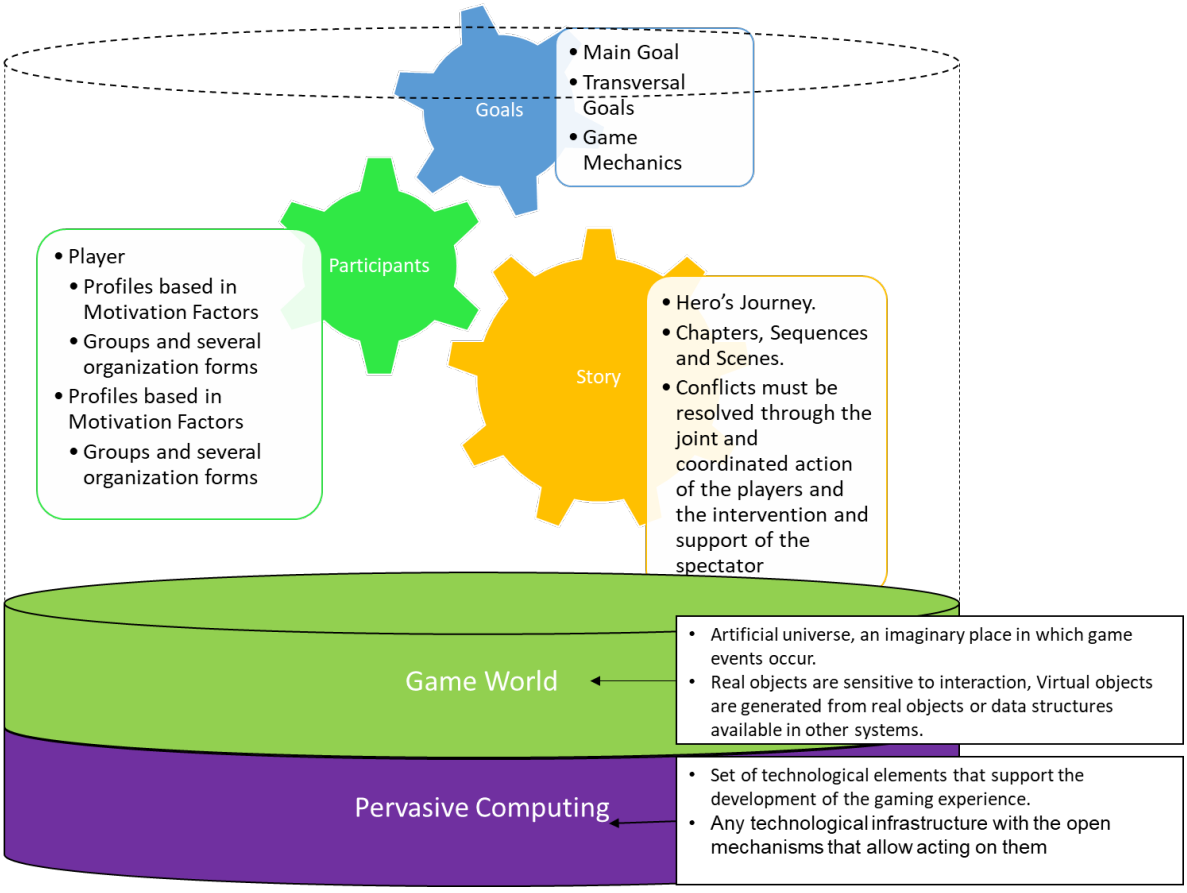


FIGURE 1. SocialPG, General View from Model.

Each of the layers and the activities and functionalities that are executed in them are presented in greater detail below.

4.1. Goals, Game Mechanics and Game Elements

Goals are objectives that a person or system wishes to achieve. In the context of a game, goals give the player a sense of achievement or progression (Weitze, 2014), goals are traditionally quantifiable, so they can be measured, thus it is possible to know when a goal has been achieved. Feedback in games is a very important mechanism to communicate to the player his progress, with it can be communicated trophies, badges, points or unlock new challenges and goals.

The main attributes that an objective must have to be balanced and appropriate:

- Goals should be concrete so that it is clear to the player what the ultimate objective of the game is;
- Goals should be challenging, but achievable;
- Goals should be designed in such a way that the player is eager to achieve them and enjoys achieving them;
- There should be both short and long-term game objectives.

The relationship between Goals, Mechanics, and Game Elements in the framework of the Model for the construction of pervasive social game experiences can be summarized as follows:

- The goals propose a target that players must meet, in that challenges must be met through their participation in-game mechanics, they are the means to achieve them;
- Game mechanics can be a composition of other game mechanics and game components;
- The game mechanics defined for a game experience may include cooperative work activities and competition between groups of players and spectators.

Aparicio (Aparicio, 2016) proposes a method to build gamified processes based on the goals and game mechanics, in this sense, he exposes the set of elements necessary to gamify a business process, inspired by the theory of self-determination, with this main emphasis on satisfying the intrinsic needs of the individual and maintaining motivation, these needs are mainly related to, Autonomy, Mastery, and Purpose. According to the method, a gamified process can be defined by executing a basic sequence of activities. The first one consists of identifying the main goal of the task to be gamified. The second tries to identify one or several goals underlying the main one that is interesting for people. The third activity shows a selection of game mechanics according to the context in which the gamification process is being carried out.

This method exposes in a structured way the organizational objectives related to a gamified experience and details how they are achieved using a set of game mechanics, this will serve to represent in the SocialPG model the layer related to Objectives, Mechanics, and Game elements.

4.2. The Story

The interactive nature with which the story is executed allows giving the player a sense of freedom and control, for this, the designer must plan how the story unfolds, so that there can be a linear development or based on the decisions made by the player during the execution of the game experience.

There are different criteria for structuring a story, Grace (Grace, 2019) describes that an alternative can be to structure it in three sections, beginning, development and end. In the beginning, the conflict is typically generated, in the development, various actions are triggered in response to it, and the end is the phase where it is resolved. Schell (Schell, 2019) recommends the "Hero's Journey" to structure it. The hero's journey is a story template proposed by Christopher Vogler (Vogler, 1985) that involves a hero who undertakes an adventure, emerges victorious from a decisive crisis, and returns home changed or transformed, is structured in stages, and is commonly found in myths, fairy tales, dreams, and movies.

From the social point of view, it is important to incorporate stories with narrative elements involving different characters. Artificially constructed conflicts must be resolved through the joint and coordinated action of the players and the intervention and support of the spectator.

The narrative elements that make up the story must be aligned with the mechanics and gameplay elements. To achieve this, we suggest that a story can be divided into components that contain others, so that a story contains chapters, these, in turn, contain sequences and final scenes.

4.3. The Participants

The model establishes two types of participants, differentiated by the role they play in achieving the objectives defined by the designer. The players are more involved in jumping over obstacles and resolving the artificial conflict posed by the designer to achieve the expected objectives. The spectator, on the other hand, has other interests and his participation is more related to his interaction with the player and supporting him in achieving the objectives.

The motivational elements for both types of participants are different; in the case of players, there are multiple models to describe them, we will take as a reference the proposal of Marczewski (Marczewski, Even Ninja Monkeys like to play, 2015), who points out that a player is motivated by intrinsic and extrinsic rewards and, depending on this, he will create different profiles.

In the case of the spectator, Seering (Seering, 2017) describes some profiles according to the motivating factors that drive them to participate, to reach this conclusion was taken account the behavior of the viewer in various streaming sessions that are projected live next to game games, in this sense:

- Helpers, advise the player to achieve the goals of the game;
- Power Seekers, participate with the sole goal of having an impact on the Game, whether it is useful or detrimental to the Player;
- Collaborators, integrate with the Player and other spectators to support the completion of the game;
- Solipsists, these participants focus on getting personal benefits from the game, such as learning to use a new tool or meeting new people for opportunities;
- Trolls. These spectators focus on intimidating and harassing the Player.

The level of knowledge a participant has about what they can and cannot do within the Game and what type of role they are playing at any given time is called their level of awareness. This can be used in different ways in different game mechanics. The interchange of roles is contemplated, that is, at a given moment of the experience a Participant can be a "Player", but at any moment of the story, he/she can become a "Spectator", and vice versa, with this new ingredient is included that allow other types of interaction with the experience.

4.4. Pervasive Computing, Application Integration and Game World

Pervasive computing refers to the set of technological elements that support the development of the gaming experience, this includes all advances related to connectivity, miniaturization, and computing power that once deployed in a physical space serve as intermediaries between the participant and the real world. This layer can be adapted to achieve communication with other technological infrastructure, open and standardized mechanisms can be used to act on them or capture events that can be translated and interpreted as concrete events within the gaming experience.

Baca (Baca, 2009) suggests a wide variety of pervasive devices used in Sport to monitor the physiology of the person, levels of effort, movement, and location, which can be transferred to the construction of game experiences, expose the wide variety of protocols and barriers encountered when using them in software applications. This represents a point of attention when developing pervasive social game experiences since they must be prepared to adapt quickly to this variety of alternatives. In this sense Buzeto (Buzeto, 2014) performs an analysis about the reconfiguration and adaptability of applications that use pervasive devices, for this, he establishes different levels, that is, Level 1 - Incorporation of new Devices, Level 2 - Adaptation to the features available in the devices, Level 3 - Adapting the Story and Mechanical Features to the Context.

5. Reference Software Architecture for Pervasive Social Gaming Experiences

Using the framework of SocialPG (Valera-Aranguren, 2021) a reference software architecture is proposed that can be used to understand the complexities and challenges that the developer must face when building pervasive social game experiences.

This reference architecture must be flexible enough to incorporate pervasive devices of different natures easily and quickly. It must allow for integration using simple dynamic configurations while supporting the heterogeneous nature of communication with existing devices, the intermittency of communication, and the different ways in which participants can interact.

The game world is composed of real objects, virtual objects, or a bit of both, and must be linked to the narrative discourse crafted for the experience. The participant must be able to interact with them directly or through a specially designed intermediary device. When the game world is virtual, a device or medium may be needed to visualize it, this could be for example a mobile device, in this case when using it, additional technological resources such as Augmented Reality or Virtual Reality can be deployed to make the experience more interesting or immersive. (See FIGURE 2)

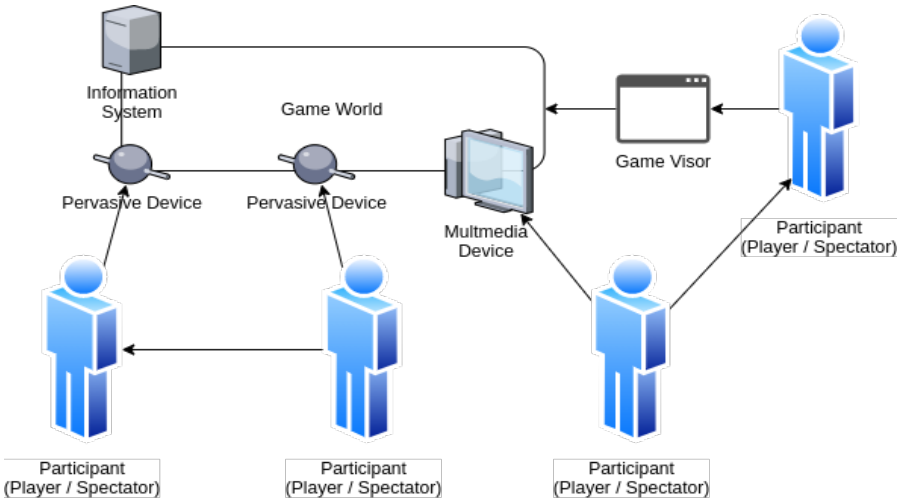


FIGURE 2. Functional Schema in Pervasive Social Experience.

The goals and game mechanics must be channeled by the reference architecture, in this way, the actions performed by the participants on the game world or the changes detected in it can be interpreted as events that must be processed, identified, filtered, and transformed into useful information elements for the designed game mechanics.

The software architecture must support a set of functionalities according to the reference model defined by SocialPG, that is:

- Incorporate in a geolocalized physical space pervasive computing device, to establish communication mechanisms that serve to collect interactions of the participants and detect changes of environments that have a specific meaning in the designed game experience.
- Build Game Worlds with real components sensitive to context and interaction by participants, virtual or both.
- Define and Monitor a structure of Objectives established by the game designer.
- Control the life cycle of the experience by activating game mechanics that are aligned with the proposed goal structure.
- Ensure interaction among participants through communication and collaboration.

- Offer the participation of spectators with the possibility of role exchange, a spectator can become a Player.
- Allow collaborative work between Spectators and Players.
- Allow Game Mechanics based on Augmented Reality or Virtual Reality.
- Guarantee feedback to the participants of the experience when an individual or collective Game actions are executed. This refers to the possibility that a participant can, at the designer's convenience, know that other people are participating in the experience, what role they are playing.

There are two processes inherent to the execution of a Pervasive Social Gaming experience that must be supported by the Architecture, the first is related to the configuration of the game world and the definition of objectives and mechanics, the second has to do with the management of the interaction of the participants during the development of the experience.

The configuration of the game world is related to the structuring of the workspace in which the interactions of the participants are developed, there are specified the pervasive computing elements that integrate it, the way to communicate with them, and their geographical distribution in the case that applies, in this way, the bases are created to activate the communication and consequently receive the changes of states product of the interaction of the participant, in specific conditions, these devices can receive commands that allow them to change state and take determined behaviors according to the needs of the designer.

To handle these configuration aspects, a document constructed in a standardized interchange format should be provided containing information related to:

- Pervasive computing devices, that is, list of devices (sensors, actuators, multimedia devices, among others) that are of interest for the experience, thus, indicating the type (Input, Output, Input/Output), form of communication, lists of available commands, actual physical location, among others. Given the wide variety and types of devices, specific components can be created to handle communication and interaction with each family of devices.
- External systems, the necessary connection parameters are specified for the interaction with each system of interest (Communication Protocol, Authentication Scheme), specific components are built with the necessary programming logic to extract the data from the final system and perform the update processes that may be required.
- Definition of the Game World, refers to the characteristics of the different physical spaces where the Game activities are developed, thus, the pervasive devices of interest, the objects derived from the external systems that will be deployed, participants authorized to interact, among other elements, are indicated in a delimited physical area or not.

The Goals are a hierarchical structure of definitions that serve to represent the ideal state of the experience, they are expressed through management indicators that are calculated according to the concepts used in the design, with this it is possible to establish the gap that exists between what the designer wants and what happens. The goals can be chained to each other so that their activation can be subject to specific conditions defined by the designer, likewise, each goal is achieved through the execution of one or more game mechanics that are sensitive to the context, so that they react to changes of states produced in the objects that make up the game world, in this case, they encourage the participation of the different roles configured or activate additional mechanics that correspond to the designer's objectives.

The configuration of the structure of the goals together with the game mechanics must be expressed through some kind of document in a standardized format that can be automatically interpreted by some software component, thus it must contain:

- List of Goals together with the dependency between them, for each goal should incorporate information regarding its activation conditions, type of participant involved (Player or Spectator), measurement indicators and expected values, as well as the associated game mechanics.
- Set of Game Mechanics, that is, an inventory of mechanics that will be used to control the interactions of the participants, establishing the activities that are required, the form and order in which they are executed, the types of participants involved, the area of the game world where they are valid, the game mechanics to be used and their corresponding form of activation.

Another key activity that the architecture must support is the management of the interaction of the participants, in this sense, it must provide the user authentication mechanisms to be incorporated into the designed game mechanics. The context-sensitivity of the game world allows detecting the presence of new participants and according to their profile the type of actions and activities to which they have to access is filtered, if the game world has objects in real physical space it can accept interactions (direct or indirect) of the participants that are part of the experience; likewise, in response to the activities of the participants the game mechanics can trigger events that involve communication to the pervasive devices arranged in the field, thus it is expected that they can change their state and consequently provide feedback on the actions performed.

The economy of the experience is based on the management of points, any activity executed by the participants leads to the activation of some type of reward that can be expressed in this unit, in this way various gamification elements can be used to improve motivation, such as badges, avatars, and leaderboards, the management indicators used to measure the objectives can be expressed using this type of elements.

The incorporation of participants in the framework of game mechanics involves the conformation of different forms of organization and social integration schemes such as competition, collaboration, and communication. Once the activities are taking place, specific objectives can be achieved that trigger the activation of other similar ones according to the configuration defined by the designer, consequently, new mechanics are activated that encapsulate new challenges and work schemes.

Sometimes the interaction of the participant with the game world is done through a pervasive device (cell phone) with a software component specially designed for the experience, in this case, it can present the game world according to the narrative and the story established by the designer showing graphic resources consistent with the proposal and taking advantage in some cases of technological elements such as virtual reality and augmented reality. These devices have technological advances that guarantee mechanisms to detect within a radius of proximity certain objects related to the experience, as well as participants (players and spectators), with both it is possible to interact according to the objectives and game mechanics activated for that user.

To address these functionalities described by SocialPG, a software architecture (See FIGURE 3) composed of the following components is proposed:

- Pervasive Device Controller. It has the function of managing communication with different pervasive devices that are arranged in each physical space, as well as to manage the integration with external systems involved in the gaming experience.
- Game Manager. It is in charge of starting and ending the experience and can also store and summarize the status of a particular game instance. This component delivers data of different nature to the Game Visor so that it can be shown with different audiovisual resources.
- Game World Instance Manager. This component is responsible for capturing the events generated by the pervasive devices and configured information systems. It must then translate them into information elements that can be useful for running game instances. On the other hand, it translates concrete actions executed by the participants on the game objects into events of interest for active game mechanics.
- Game World Configuration Manager. It manages the configurations that define the game world, i.e., geographical limits, working hours, pervasive devices of interest that are controlled by the Pervasive Device Controller.
- Game Visor. It is the intermediary between the participant and the game experience, in this way:
    - It shows the current state of the Gameworld, for this, it can make use of technologies such as augmented reality and virtual reality.
    - It translates the intentions of the participants on virtual objects deployed in the game world, into actions of interest for the game mechanics in execution.
    - It enables collaborative actions and communication among the participants of the experience.
    - It presents the participant with the pending tasks in relation to the game experience he/she is executing, and also offers the possibility of executing them and knowing the result of the action performed.
- Participant Manager. It oversees determining the pending tasks associated with a participant, as well as of registering the completion of an area. It generates notifications according to the rules defined by the experience manager.
- Game Goals and Mechanics Manager / Game Mechanics Instance Manager / Gamification Manager. These components together have the function of controlling and monitoring the game goals and mechanics. Depending on the achievement of the objectives, they establish the game mechanics that must be activated, what types of participants are involved, and under what form of organization.

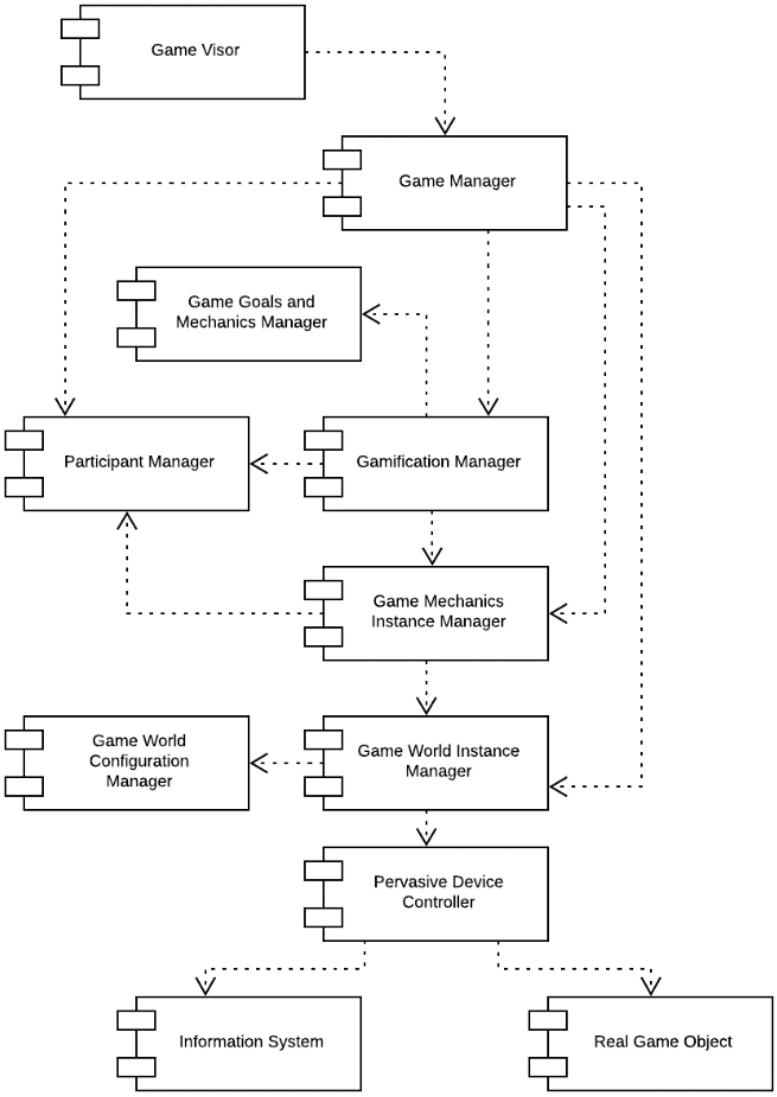


FIGURE 3. Software Architecture for SocialPG.

6. Applying SocialPG to Gaming Experiences

Once understood the use and usefulness of the model, it is proposed to apply it to a specific situation, for this purpose the process of error resolution and construction of improvement opportunities for software products that traditionally occur in companies has been selected, among the characteristics of interest we can mention:

- There is a group not directly related to the development process that reports error conditions and improvement opportunities;
- The process advances through intense communication within the development team;
- Multidisciplinary work teams can be formed to solve errors and materialize opportunities for improvement;
- Consensus strategies exist within the team to address problems.

The process of resolving bugs and building improvement opportunities begins with the generation of a document that describes the detected bug or functionality that can improve the performance or scope of the software product. This process, in many cases, is automated by technological tools that are available in the cloud. These tools are internal consumption utilities for the company's employees that are used to control the entire lifecycle of the process. These tools are closed to the participation of people outside the development process. As a result, the opinions, and perceptions of the end-users of the product may not arrive quickly enough and with sufficient clarity to successfully meet expectations. Consequently, the organization will not have the possibility of knowing firsthand the perceptions and concerns that the users of the application may have.

Once the report is generated, its life cycle begins, in this case, the initial activity is the evaluation and assessment of its relevance. If the report is deemed to be valid, it is assigned a priority and a work plan is established that sets the course to be followed for its resolution or conclusion, depending on the type of report created. (See **FIGURE 4**)

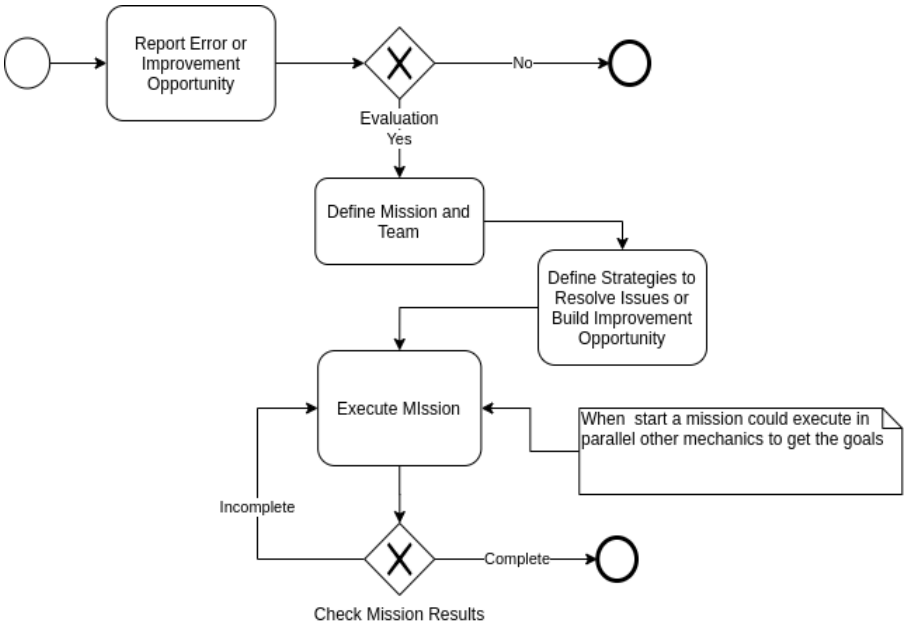


FIGURE 4. The process of resolving bugs and building improvement opportunities.

6.1. Formulating The Goals

Using the method proposed by Aparicio (Aparicio, 2016), the structure of the goals of the experience is exposed, decomposing them into main and transversal goals, as well as identifying the game mechanics with which it is expected to achieve them, the design of each mechanics should have as a priority to maintain the motivation of the participants using fun elements and games.

6.1.1. Main Goal

The main goal of the experience is to guarantee the maximum level of operability of a software product through the early attack of problems and the identification of improvement opportunities. Suggested indicators, Number of valid bug cases and improvement opportunities reported per

week, Number of bug cases and improvement opportunities resolved per week, Average resolution time of reports (bugs and improvement opportunities) per month.

6.1.2. Tranversal Goals For End-Users

Reward valid bug reports, and enhancement opportunities reported by end-users. Suggested Indicators: Number of correct and approved bug reports and improvement opportunities per week, Average time to approval of a bug report and improvement opportunity, Frequency of bug reports and improvement opportunities per application per week, Number of interactions developed per application per week.

6.1.3. Transversal Goals For Developers

- Encourage the participation of developers in the effective resolution of detected problems, as well as in the implementation of new functionalities approved for the application. Suggested Indicators: Number of actions executed on Reports and Improvement Opportunities per Developer per Week, Average time of attention to cases per application;
- Encourage continuous interaction between end-users and developers. Suggested Indicators: Number of social interactions performed per Participant per week.

6.1.4. Game Mechanics For End-Users

- The end-user will execute missions designed by the application administrator, which will activate different types of activities with varying levels of difficulty and rewards, as well as establishing criteria for their start and completion, such as time limits, location restrictions, etc. (PBL Cycles (Points, In-signs, Rankings));
- The initiation of the participant in the experience includes the awarding of points that affect the participant's score. (Engagement Cycle);
- The participant earns points as he/she performs activities in the experience, these allow unlocking Badges and Avatars that can be seen in the user's public profile. (Progression Cycle).

6.1.5. Game Mechanics For Developers

- Developers execute missions based on collaborative work, the resolution of bug reports and opportunities for improvement includes joint activities of participants with different types of skills. Successfully completed missions and the completion of individual activities generate rewards that are reflected in point scores (PBL Cycles (Points, Badges, Rankings));
- Interactions between end users, between developers and between end users and developers generate some type of reward that is reflected in the participant's point score, this type of reward will serve to identify those participants who have some leadership related to communication and social interaction (PBL Cycles (Points, Badges, Rankings));
- The participant's initiation into the experience includes the awarding of points that affect the participant's score. (Engagement Cycle);

- The participant earns points as he/she performs activities in the experience, these allow unlocking Badges and Avatars that can be seen in the user's public profile. (Progression Cycle).

6.2. Defining The Story

The experience is set in a medieval forest, a mystical environment led by magic and creatures of light, a time of castles and wizard guilds where all actions are based on justice and honor. In this world, extreme situations can occur that can affect the welfare of all, so there is a group of magicians who meet to address and resolve them.

Creatures of light offer the energy and good vibes to ensure that the world remains in balance, consequently, the illness of one can be chaotic and make it a hostile place to live. The brotherhood of Mages is the main responsible for the health of these creatures, they have the spells and tools necessary to ensure their health, they always work to maintain the balance of the world.

In this medieval world, there are nomadic people, Collectors, who over the years have cultivated knowledge to understand the creatures of light. They can perceive when they are in trouble, their function is to help them by commenting this situation to the group of wizards, as they are the only ones who have the spells and tools to save them.

When a Collector communicates a problem to the Council of Wizards, a set of activities are executed, first of all, it is verified if the situation is true, then a council is summoned that will be responsible for working on the resolution of the situation in such a way that wizards with different types of skills and abilities can intervene in this council, A mission is made to coordinate the teamwork and thus solve the situation, finally, it is verified if it was solved, if it is true, the mission is finished, if not, the work to solve the problem continues.

The council of magicians can design missions to motivate the collectors to participate, there they can detail activities that lead to determine the state of health of the creatures and to execute verifications related to new powers incorporated into them.

In general, this narrative context presents a single chapter story, the activities take place in a Medieval Forest where Creatures of Light, Mages Guild, and Collectors Group meet, there is also a continuous work between collectors and mages to ensure that the creatures of light are kept healthy.

6.3. Building the Game World

It is necessary to match the elements of the story with the conceptual elements used in the process of managing bug reporting and capturing improvement opportunities for software products, so we have:

- The application on which the bug reporting, and improvement opportunities process is performed, are called Creatures of Light.
- The associated concept to represent the work plan made to respond to a bug report or improvement opportunity is called Mission. There are work plans that can be taken by the collectors, based on activities designed by the mapping council, which aims to direct their motivation to concrete activities related to validate the health status and detection of opportunities in a creature of light.

- The end users and the team of people who are not directly related to the development process are called Collectors.
- All people who intervene directly in the development process either for bug resolution or incorporation of improvements to the product, are called Wizards.
- The detection of bugs or improvement opportunities made by the re-collectors is called reporting.

7. Agatha - A Pervasive Social Gaming Experience

To give a more complete view of the nature of the pervasive social game experience designed based on the SocialPG model (Valera-Aranguren, 2021), an advanced prototype called Agatha was built that implements some of the mechanics laid out in the design.

Agatha consists of a mobile application and a web application in which a game world is deployed with objects related to the story and with which both types of participants interact. Depending on the type of participant, either a Spectator (Collector) or Player (Wizard), the application will present different perspectives of work.

The objective of Agatha is to coordinate the work of the participants to maintain the health level of the creatures that live in the Medieval Forest, in this way, the collectors work to look for problems and suggest elements that guarantee that the creatures are better, the wizards, on the other hand, are focused on curing the health problems found and ensure that the suggestions made to make them work better can be done.

Agatha always presents to the participants the state of health of the creatures, as well as the activities in progress, both to solve the problems detected and to improve the performance so far. (See Figure 2)

Viewers will participate in challenges built by the development team under the figure of Missions, this aims to direct their efforts around specific activities to check certain conditions of operation of the application or to generate opportunities for improvement under particular test scenarios, it is expected to stimulate participation through motivational factors related to social recognition and mastery, in this sense, a cycle of acquisition of points and conformation of leadership chart is used, also the unlocking of Avatars that will be delivered depending on the level of progress and contributions made in the application. (See FIGURE 5)

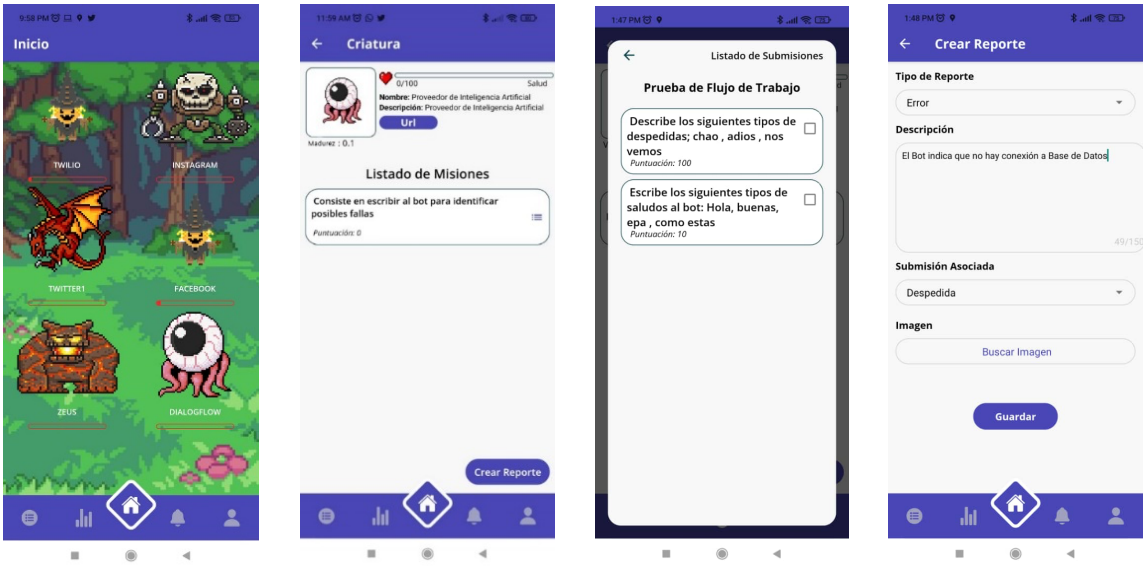
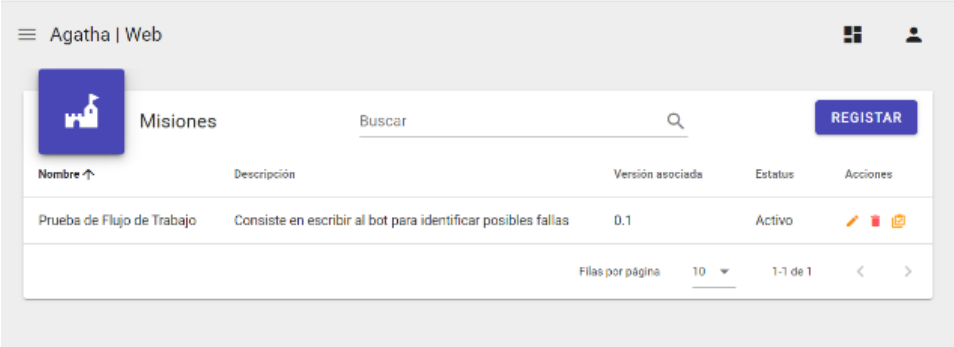


FIGURE 5. UI for Recolectors, Working in Missions and Create Reports.

The activities of the developers are established based on the failures and opportunities for improvement detected in the missions performed by the end users, once they have been evaluated and approved, a Developer Mission is formed, which is a work plan with a set of activities distributed among the registered developers to address it, the intention is to incorporate motivating factors such as competition and recognition so that these missions are performed in the shortest time and with the highest possible quality, For this purpose, it is proposed to add a work cycle based on obtaining points for completed tasks, the amount of points obtained as rewards are calculated based on the time of completion and the complexity of the task, then, these are used for the delivery of trophies between developers with similar professional characteristics or the unlocking of Avatars based on the performance obtained in the experience. (See FIGURE 6)



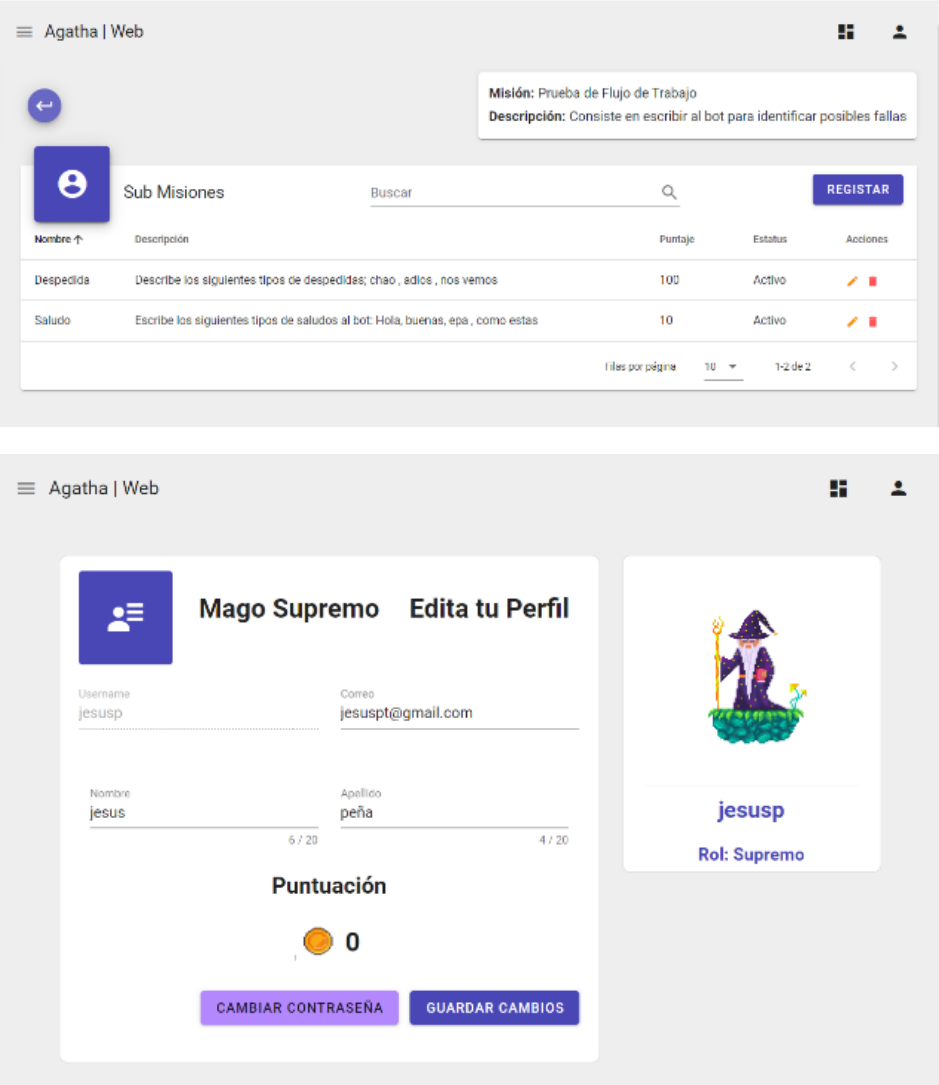


FIGURE 6. UI For Wizards, Execute Tasks in Missions and Get Feedback

Agatha supports a single game world involving two types of participants driven by different objectives, consequently, game mechanics that differ in design and structure are used, for end users it is more important to highlight their participation and expertise, for developers it is more important to boost the speed and effectiveness with which the tasks are developed.

8. Pervasive Social Gaming Experience Validation

This section of the article describes a validation process performed on the pervasive social gaming experience implemented in Agatha, its objective is to identify the degree of satisfaction experienced by a group of people when executing error resolution activities and implementation of improvement opportunities under the approach of active participation of the viewer (End User).

Application

A group of people with various levels of expertise in the area of software engineering who have direct responsibilities in corrective maintenance activities were selected. (State the Demographic Nature of the Participants)

Before conducting the game experience evaluation, the interviewees were given training on the processes built into Agatha, explaining the role of each component and the perspectives built for the End User (Spectator) and Developer (Player) roles.

Each of the interviewees interacted with the tool, executing the whole work cycle designed for both the End User and the Developer, starting with the creation of a light creature, then defining a mission that aimed to collect some bug reports or improvement opportunities, then the interviewees in the role of the end-user ran the application to discover the process of performing missions, in which they could generate error reports and opportunities for improvement, then verified the process of acquiring points, as well as the generation of the ranking of leaders and the unlocking of the Avatars available in Agatha.

The reports of both errors and opportunities for improvement were processed by the interviewees from the perspective of the Developer, all of them gave the necessary course to some of them so that they could build a mission that would involve other participants and then through the concretion of the planned activities they could verify the reward schemes, conformation of the leader board and exchange of Avatars.

At the end of the execution of the work cycles designed, an instrument consisting of 3 sections was applied, one dedicated to detailing the profile of the interviewee and the other two to collect opinions on the design and implementation of the error management process and opportunities for improvement, special emphasis is placed on their appreciation of the differentiating aspects that Agatha has concerning the traditional process they used to manage and the motivating factors that have been included in the game mechanics constructed, especially their effect on the effectiveness with which the activities are carried out (See TABLE 1).

Table 1. Description of the survey sections.

Section	Description	No. of Questions
General information about Software Developer	In this section it is required to identify the profile of the software developer and to understand how he executes the activities of solving errors and building new software artifacts.	5
Generalities About the Built Software Product	Questions to collect opinion in general terms of the built application.	3
Details about the Functioning of the Built Software Product	Questions to collect details about the operation of the game mechanics built for both the viewer (End User) and the player (Software Developer)	7

The instrument contains closed questions in two variants, some with a Yes/No answer and others with a 5-point Likert-type scale, ranging from 1 (Completely Disagree) to 5 (Completely Agree), for its application, a form was constructed with the Google Forms tool, it was distributed by e-mail to 17 selected interviewees and then a maximum period of 5 days was established for its delivery.

Results

The results are based on the automatic totalization made by Google Forms of the answers provided by the interviewees, once the maximum period for submission of the instrument had expired.

About the Interviewee Profile, their participation in the Software Development Process, and how they execute the activities of error control and implementation of improvement opportunities in their organizations.

- The average age of the interviewees is 29.05 years old with a standard deviation of 5.96. 56.25% are male and 43.75 are female.
- Most of the interviewees work mainly in Backend Development (41.2%) and Frontend (47.1%) activities, however, some of them execute simultaneous roles in the team, Software Architecture, and Database administration.
- 88.2% of the interviewees claim to use some kind of software available in the Cloud to control the process of error resolution and development of improvement opportunities. The remaining 11.8% use local software installed in the companies where they work.
- Among the main software tools used to control the process are Trello used by 35.3% of the participants, ASANA by 29.4%, and JIRA by 23.5%.
- Concerning the type of people who participate in the process of solving problems and building opportunities for improvement, the interviewees expressed that in their organizations, failures and new functionalities are mainly reported by the developer himself (76.5%).

On the General Appreciation of the Application Constructed

- 100% of the interviewees are agreed that AGATHA represents a differentiating alternative for other tools used for the control and follow-up of errors and opportunities for improvement.
- Among the differentiating aspects of AGATHA, the interviewees agree that: Encourages Voluntary participation 88.2%, Incorporates the End User 58.8%, Is Easy to Use 70.6%, Is Fun 52.9%.

On the Work Perspective from the End-User's point of view

- 94.1% of the interviewees consider that the Missions aimed at end-users constitute a work unit that channels efforts to develop specific tasks of interest.
- In general, the appreciation of end-user participation in the process of reporting errors and building improvement opportunities is very positive. (Very Positive 52.9%) (Positive 35.3%).
- The perception about the delivery of rewards as a motivating factor in the development of experience in which End Users participate is positively valued. (Very Positive 47.1%) (Positive 29.4%).
- The scheme of work proposed by Agatha is positively rated for interlinking efforts between End Users and Developers. (Very Positive 58.8%) (Positive 17.6%)

On the Work Perspective from the Developer's point of view

- The perception about the delivery of rewards as a motivating factor in the development experience in which Developers participate is rated Positive. (Very Positive 41.2%) (Positive 29.4%).
- The teamwork promoted by the Developer missions that revolve around error reports and improvement opportunities is rated as Positive. (Very Positive 64.7%) (Positive 11.8%).

Analysis of Results

AGATHA presents a game world that is shared by two types of participants, the end-users and the developers. In the case of the end-users, they are not presented with direct information associated with their role and how they collaborate in the achievement of the central objective, which is the direct responsibility of the development team, which is to procure software free of errors and with opportunities for improvement that will allow them to be competitive in the market in which they operate.

The interviewees' organizations do not consider end-users in the process of detecting errors and building improvement opportunities; however, incorporating them, according to the interviewees, can have a positive impact.

The use of Missions with End Users constitutes an important element to encourage participation and satisfy the testing needs of the development team, the use of motivating factors such as public recognition and fun contribute to the effectiveness with which they are developed.

Developers structure their activities in Missions based on error reports and improvement opportunities provided by end-users, the use of rewards such as points, badges, avatars, and leaderboards, is a driving factor of healthy competition from which advantages such as the execution of activities effectively and efficiently are derived.

9. Conclusions and Future Work

SocialPG is a model to guide the designer in the construction of pervasive social game experiences in the initial stages of design, it intends to present an integrated view of all the components that may be required to achieve it. In the selected case study (Process of error resolution and execution of improvement opportunities in software products), a goal structure environment was designed in which a set of game mechanics are executed, the story was used to set the game objects and to build the terminology used in the development of the planned activities. Two types of participants are included, some directly responsible for the achievement of the objectives (Developers) and others that serve as support to achieve them (End Users).

With the game experience built, a workflow is generated between End Users and Developers, the fun and challenges built throughout the experience become motivating factors that contribute to the development of the assigned activities and serve to stimulate participation. The use of gamification schemes, such as the accumulation of points, badges, avatars, and leaderboards, can be used as a measuring factor to determine the gap between the current situation of the experience and the desired state, as well as to highlight the public knowledge and expertise of the participants, which eventually leads to the incorporation of additional motivational factors to leverage the experience.

The initial version of software architecture to support pervasive social gaming experiences was presented. Among the most relevant aspects, it was shown how a participant can interact with the

experience through a Game Viewer or directly on the devices located in the Game World. Also listed were a set of functionalities of the Architecture that pose significant challenges in the implementation process, this includes:

- Adaptability in the face of heterogeneous nature of devices and pervasive objects that can be integrated into a game world.
- Control and monitoring of the Objectives structure.
- Activation and tracking of game mechanics according to the objectives defined by the Designer.
- Support of diverse alternatives and means for the synchronization of the work among the participants.

The software proposal that will support the pervasive social game experience is a mobile application that for the architecture represents the "Game Visor" component, which will present story elements in the form of visual elements and will serve as an intermediary between the participant and the experience to facilitate the interaction between Players and Spectators. Technological tools such as Augmented Reality and Virtual Reality can be used in this "Game Visor" to increase the immersion of the Participant.

In the pervasive social game experience created two work cycles are executed simultaneously in the same game world, on one side are the game mechanics built for end-users and on the other the ones designed for the development team, there is the chaining of the results produced in both mechanics, the end-users produce reports that are then processed by the development team, however, The level of awareness that end users have about how the generated reports are processed and how they are resolved is ambiguous, this is an element of the social expansion of games that can be used in other works to incorporate new elements, thus making it more attractive and adding motivational resources that serve to boost participation, the interviewees mostly agree that this work proposal can help to boost the synergy between both parties.

The evaluation carried out on the game experience built showed that the participation of the end-user is very positive, especially to address business goals, their incorporation into the missions designed by the development team allows directing their efforts towards aspects of greater relevance to the organization, The game mechanics that are based on the premises of rewards and social recognition is an aspect that contributes to maintaining motivation in the development of the activities, it also serves to promote communication between the end-user and the development team, something that traditionally does not happen in the current schemes for detecting failures and building opportunities for improvement.

For those interviewed, the use of missions as a fundamental work unit in the experience is very positive, to coordinate the efforts of developers and end-users, in addition to offering a limited framework in time and space to ensure the resolution of a problem or the construction of an improvement opportunity, where motivational mechanisms are used to promote competition among participants and thereby strengthen efforts to solve the problems encountered.

It is expected to incorporate to SocialPG a notation that serves to represent the goals, mechanics, and game components, which additionally can be used as configuration elements within the Software Architecture to control and monitor them. Likewise, it is important to establish a method to express the metrics of the goals that are calculated according to the gamification elements used or to the objects of the problem domain involved.

The results obtained with the application of the model in this case study, allow us to suppose that it is possible to use it in other scenarios, such as Education, Medicine, and Citizen Management.

The context-sensitivity of the game mechanics and the quantitative definition of the goals are two very important elements to be able to implement dynamic game mechanics, i.e., mechanics that are self-regulating and adaptive according to the constant monitoring of the goals and the desired values for them, it remains to understand a little more about the areas of application in which it can be implemented and the additional elements that must be taken into account to achieve it.

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