GeoPGD: Methodology for the Design and Development of Geolocated Pervasive Games

The field of design and development of games that integrate virtual aspects in a real environment has had a growth in recent years. An example of such games are Pervasive Games (PG), which seek to enrich the game world through the union of these two realities in order to better involve the player in the story. The application of PGs has resulted in an increasing player motivation and engagement. Currently, new technologies have made it possible to advance in the design and development of games. PGs have not been the exception, and through the union of elements of traditional games with real elements and scenarios It has been possible to improve motivation and User eXperience (UX). However, previous studies have identified the need to have a process that guides the design and creation of PGs. Therefore, this paper presents GeoPGD, a methodology that integrates the design of geolocated narrative as the core of the game experience. This methodology guides designers and developers through the different stages of building a PG, giving them tools for defining the narrative components, places and interactions between the user and the PG. In addition, a validation with experts and a PG experience is presented.

Key words: Pervasive Games, Videogame Development Methodology, Interactive Narrative, Geolocation, Game Development.

INTRODUCTION

This paper is based on a previous published work with early results (Arango-López, J., Gallardo, J., Gutiérrez-Vela, F. L., Amengual, E., & Collazos, 2018), which presented a first draft version of the methodology at the beginning of this research. Games have been present in people's lives for a long time. The use of computing technology to improve everyday life continues at an exponential rate (Maglogiannis, Makedon, Pantziou, & Betke, 2014). Traditional games involved the use of physical elements. Later, video games appeared and revolutionized this field, including the use of specific devices and important technological advances, attracting a good number of new players. Some of the keys to the success of video games with respect to traditional games are: the creation of the illusion of being immersed in a virtual world with

computer graphics and sound, the definition of challenges typically more interactive than those of traditional games and the design of games with an optimal level of complexity (challenges, levels, interaction, etc.), which can provoke the curiosity of players in an easy and continuous way (Magerkurth, Cheok, Mandryk, & Nilsen, 2005).

Subsequently, the concept of videogame has evolved, adapting to the technological advances of each era, which in some cases have led to substantial changes in the concept of game. Thus, new interaction paradigms have recently emerged, such as ubiquitous computing, ambient intelligence or tangible interaction (Remagnino & Foresti, 2005; Shadbolt, 2003). These paradigms have led to the dispersion of computational capacity in smaller and smaller devices and in physical objects of daily life.

In this way, games have also evolved by incorporating these paradigms, and the concept of PG has emerged. According to Montola in (Montola, 2005), a PG is a game that breaks the traditional boundaries of the game, defined in terms of its spatial, temporal and social dimensions. When producing PG, according to this new paradigm, the particularities of these games must be taken into account, as well as their specific characteristics given by the pervasive expansions of time, space and social interaction, those that are not present in traditional games. However, it is rare to find specific development processes for this type of games. It should be noted that the absence of standard methodologies to guide and organize game development can result in longer, less efficient and less predictable production processes (Saavedra, Rodríguez, Arteaga, Salgado, & Ordoñez, 2014). Therefore, PGs require some kind of development process that takes into account their particularities.

In previous works, we have dealt with issues related to the development processes for videogames (Padilla-Zea et al., 2015). From that experience, in this paper

we are going to propose a design process for PG that will be reflected in a set of models reflecting the fundamental aspects of them. After reviewing the literature (Arango-López, Collazos, Gutiérrez Vela, & Castillo, 2017), we have considered one of the fundamental aspects that will be dealt is the narrative, a subject that is often neglected when it comes to producing a game. However, it has been shown that narrative is a very important aspect in providing better UX and maintaining the interest and motivation of the player (López-Arcos, Gutiérrez Vela, Padilla-Zea, & Paderewski, 2014). Along with narrative, other aspects such as game world, rules and dynamics are the fundamental axes of the presented development process.

This paper is structured as follows: Section 2 presents the conceptualization of the research topics. Section 3 presents a compilation of methodologies used in the development of videogames, which have been adapted from traditional software development. Section 4 presents the GeoPGD methodology, its phases, components and diagrams. Section 5 presents the validation by experts from academy and the video game industry. Section 6 presents the Discovering-EAM game experience that allowed the validation of the methodology from the perspective of the end user. Finally, section 7 presents the conclusions and future work.

BACKGROUND

In the environment of game development, and specifically PGs, there exist definitions for their main components and for the technologies used in their construction. In order to have a better understanding, their concepts and contributions are presented below.

Pervasive Games

Pervasive computing environments have permeated current research and practice, unobtrusively augmenting existing environments with digital content (Margetis

et al., 2015). PGs have grown rapidly in different fields, as evidenced by the proliferation of designs of documented PG (Kasapakis & Gavalas, 2014) experiences. In a previous work (Arango-López, Collazos, et al., 2017) we found several developments resulting from designs of experiences in contexts such as education, health, entertainment and tourism, among others. We have proposed a definition of PGs, based mainly on this work, from a UX perspective (Arango-López, Gallardo, et al., 2017). This definition is as follows: "A PG offers the player an enriched game experience through an evolution of game dynamics, expanding the game space according to the context in which it is played. In this way the limits of the game world are broken, making reality part of it, and the elements present in that reality can have an influence on the game".

Figure 1 – Components of a pervasive gaming experience.

Pervasive Narrative (PN)

The term narrative refers to a specific instance of a story, which is presented as a generic sequence of events with potential for narrative expression (Padilla-Zea, Gutiérrez Vela, López-Arcos, Abad-Arranz, & Paderewski, 2014). In the case of games, narrative is an element that provides order to the player's experience; through it the player finds the logic of the game and perceives the meaning of the different elements that make up the game. Because of this, the narrative can be considered as the strongest component of the games, the one that links all the other components in a coherent story, generating a direct connection between the effectiveness of the narrative and the game experience (Stach & Schlindwein, 2012; Valente & Feijó, 2014a). In the case of games,

the narrative evolves according to the decisions made by the player during the execution of the experience.

Innovative Technologies

Research is currently underway on the technologies that can be used to create gaming experiences. The goal is to optimize their performance in order to improve the results. The following is a description of the main technologies being used in games of a pervasive nature.

Location Sensors

Localization in game experiences becomes an important part when experiences must be generated in real world places. This location can occur in two types of environments: (i) open spaces, which allows the generation of game stages in geographically distant spaces, in which levels and/or parts of a mission can be integrated; and (ii) closed spaces, in a local way, where the devices and techniques used differ from those used in open spaces.

Augmented Reality (AR)

The AR paradigm is a breakthrough in the integration of the real world with the virtual world, and allows players to get a better gaming experience. Developers can devise new concepts to generate an enriched gaming environment. This type of technologies is linked to pervasiveness in the game world, since they allow to break those limits of the game, acting on mixed game environments (integration of the real part with the virtual part), as it can be seen in [21–23].

Virtual Reality (VR)

The VR paradigm has allowed the generation of completely virtual worlds, where players have a life parallel to reality (Paraskevopoulos, Tsekleves, Warland, & Kilbride, 2016) and on which they can make an interaction similar to that made in

reality. This virtual world can be accessed through technological devices such as VR glasses or similar ones. Thus, it is possible to make an almost total immersion, leading players to virtually have new friends, houses, properties, etc. This concept is different from augmented reality because here, one does not interact with elements of the real world, so everything that happens in the game stays in the game (something more in line with what is understood by classic game).

VIDEOGAME DEVELOPMENT METHODOLOGIES

In recent years, Agile software methodologies have attracted increasing interest within research and industrial environments (Bravo, Duque, & Gallardo, 2013). Which have been adapted to be used in video game development. Some of them are the cascade methodology, the incremental methodology and the spiral methodology (Schwaber, 1997). Each of them has a linear or iterative structure, and sometimes mixtures of the two are found in video game developments (Al-Azawi, Ayesh, & Obaidy, 2014). However, no methodology has been found to direct the development of PGs based on their narrative and special characteristics (Valente & Feijó, 2014b). Therefore, these methodologies have also had been adapted to this type of games, although without covering all the needs of PGs.

Consequently, the lack of knowledge of the differences between game development contexts and 'traditional' system contexts poses at least two risks: first, by being unaware of the peculiarities of game development, we miss on an important opportunity to deliver methods and tools that are directly applicable to game development; and second, by being unaware of the contextual similarities between game development and 'traditional' development projects (Daneva, 2017).

We want to explore the world of videogame development from a perspective of methodology (tools and techniques) and software development process (activities and

products). However, we are focusing our efforts on the development of geolocated PGs integrated with the narrative and its evolution. This will support the solution to the problems expressed by the scientific community as shown in (Valente & Feijó, 2014b), where authors stated that there is no methodology to follow in the development of PGs and that there is a latent need to raise the quality of the results obtained with them. Consequently, developers fail in many projects when they want to apply traditional software development methodologies in this type of games. From a developer's perspective, games differ from traditional systems in different ways, for example, entertainment requirements are subjective in games and are key for the evaluation of the effectiveness of the experience that games generate in players. Thus, maintainability is sacrificed for performance, testing and quality assurance as they are different in traditional projects (Jr, Sathiyanarayanan, Nagappan, Zimmermann, & Bird, 2016). Following this line, we are going to present an analysis of the methodologies/processes that show the lines of work that have been used for the development of games in recent years, both commercial and research.

A model defined by SPEM has been used in (Albertarelli, Dassenno, Galli, & Pasceri, 2015) for the development of several games. This model was refined through the development of gamified applications, which are executed as desktop applications and also in mobile platforms. It is a model of iterative phases for the development of games, and it always considers evaluation in each activity in the phases.

Another model considered in the development of videogames is the framework of development of serious games that is shown by Amengual et al. (Amengual Alcover, Jaume-i-capó, & Moyà-alcover, 2016). These authors consider that the specific characteristics in the development of serious games are based on a set of activities that need to be executed repetitively to deliver a solution. This framework proposes an

iterative process in two dimensions. After the initialization activity, the development is structured in three main iterations to implement the interaction mechanism, the interaction elements and the serious game, respectively.

An approach that is being followed in many companies is based on an agile development process using SCRUM that uses the traditional pre-production, production and post-production approach (Asuncion, Socha, Sung, Berfield, & Gregory, 2011; Torres-ferreyros, Festini-wendorff, & Shiguihara-juárez, 2016). This approach has been effective in the production of traditional video games. It also focuses on iterative refinement and the incorporation of incremental improvements over the software or game (Asuncion et al., 2011). The pre-production phase is directly related to the conception of the game. The conceptualization activities are implemented on the Game Design Document (GDD), which allows to capture all the characteristics of the game, its most relevant aspects and the terms of its formalization. Subsequently, the production phase implies a multidisciplinary work and those involved are in charge of the design of the elements of the game (artistic and mechanical design). In addition, the construction of the designed elements is carried out using the necessary technologies to comply with the design and the defined conceptualization. Finally, tests are carried out at different levels to guarantee the quality of the game.

As a final point the post-production phase is presented, follow-up and maintenance, as well as the generation of new functionalities, are increasingly important to maintain player's interest in the game. In conclusion, it is important to point out that the processes defined above are mostly based on iterative activities in each phase. In this way, the need to generate a good management of the game from the GDD is highlighted, since this document allows designers and developers to have an encounter point.

THE GEOPGD METHODOLOGY

This study has attempted to evaluate PGs from their design and development. This is why we have begun by detecting and classifying the main elements of the PGs (Figure 1) to propose them as the basis of the GeoPGD methodology. The general phases and components of this methodological proposal are described below.

Description of the Phases of GeoPGD

This methodology arises from the previous experience of our research team. However, concepts from the pre-production, production and post-production methodology have been collected to be adapted in this proposal. In our opinion, it is not necessary to build a new methodology from scratch. This is an approach that is similar to the one carried out when the processes of preproduction, production and post-production were adapted to the generation of digital content in videogames in a similar way to how it was used in cinematographic productions. The initial approach of the methodology is focused on four main components (Figure 2).

Figure 2 – Cyclical model of the main phases of the methodology.

The methodology is based on the key elements of the design of pervasive experiences, such as narrative, game world and its evolution and integration with reality, and the rules of the game and its expansions. In addition, as Chang et al. consider the game mechanism and rules are specifically required (Chang, Shih, & Chang, 2017), we included a set of dynamics and mechanics that appear in these experiences.

Detailed specification of GeoPGD

A detailed diagram has been defined for each of the stages aforementioned. The inclusion of a set of dynamics and mechanics that appear in the experiences because of the way in which the game world expands were considered an important part. Figure 3 shows the methodological proposal of GeoPGD in the context of elements to be considered in a geolocated PG experience, and then explains each of its phases and components. Next, we will explain in detail each of the phases of narrative, game world, rules or gameplay and the pervasive dynamics.

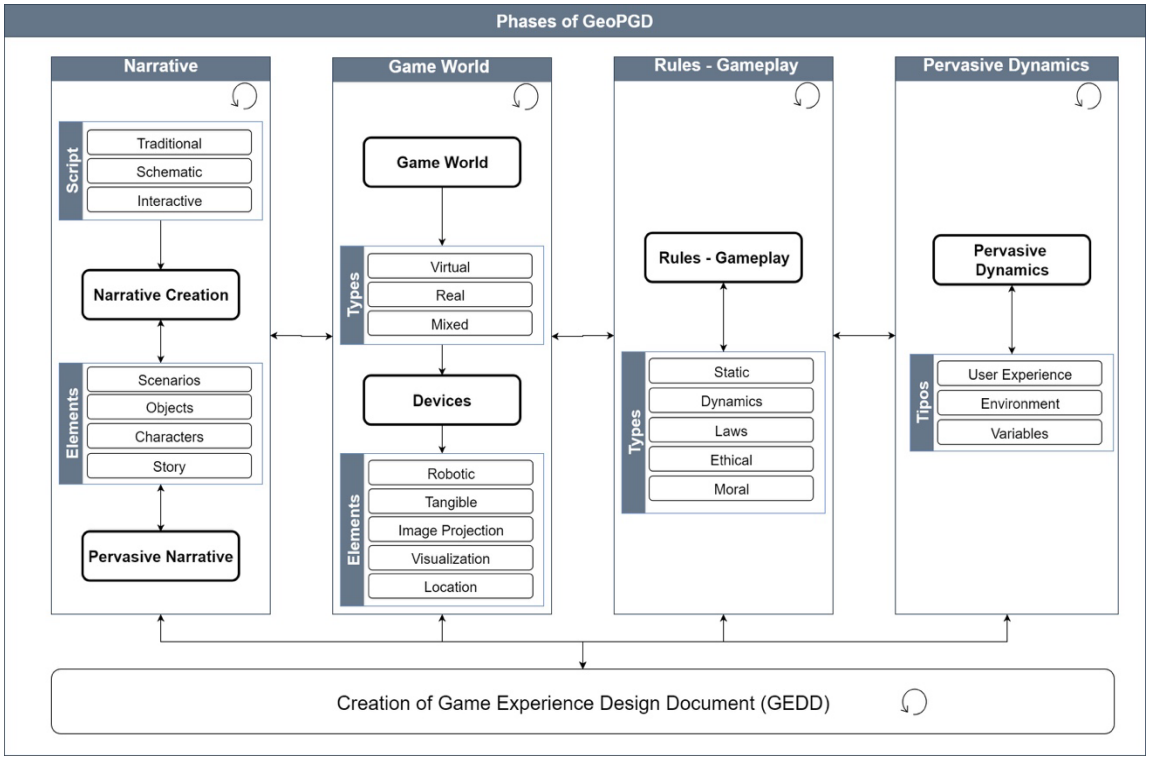

Figure 3 – General GeoPGD diagram for the design and development of Geolocated Pervasive Games.

Pervasive Narrative Design

This phase consists of the activities in which the different elements that are important in the composition of the narrative and its extension during the execution of the game experience are created. Initially, the story is based on the script, which can be presented at three different levels (traditional, schematic and interactive). The script presents the story that gives rise to the pervasive narrative, which allows the narrative to

evolve and expand through the interaction of characters, scenarios and objects of the game in the real and virtual world.

Unlike the narratives of traditional games that allow players to follow an unalterable story during the game, in our case, when we talk about PN, we express the capacity that it has to be expanded according to the events of the player and to many other aspects related to the expansion of the game. This can happen on many occasions in the real world, where social interaction makes the rules and elements variable. Therefore, the narrative must evolve to get adapted to the environment. GeoPGD has created a specific diagram for this phase, which shows the detailed components of the PN and its extension.

Figure 4 presents a Geolocated Pervasive Narrative (GPN) model as a result of the evolution of the model presented by López-Arcos et al (López-arcos & Gutiérrez Vela, 2016). This new model considers the interaction between narrative evolution and the world game (real, virtual or mixed), which leads us to obtain a GPN.

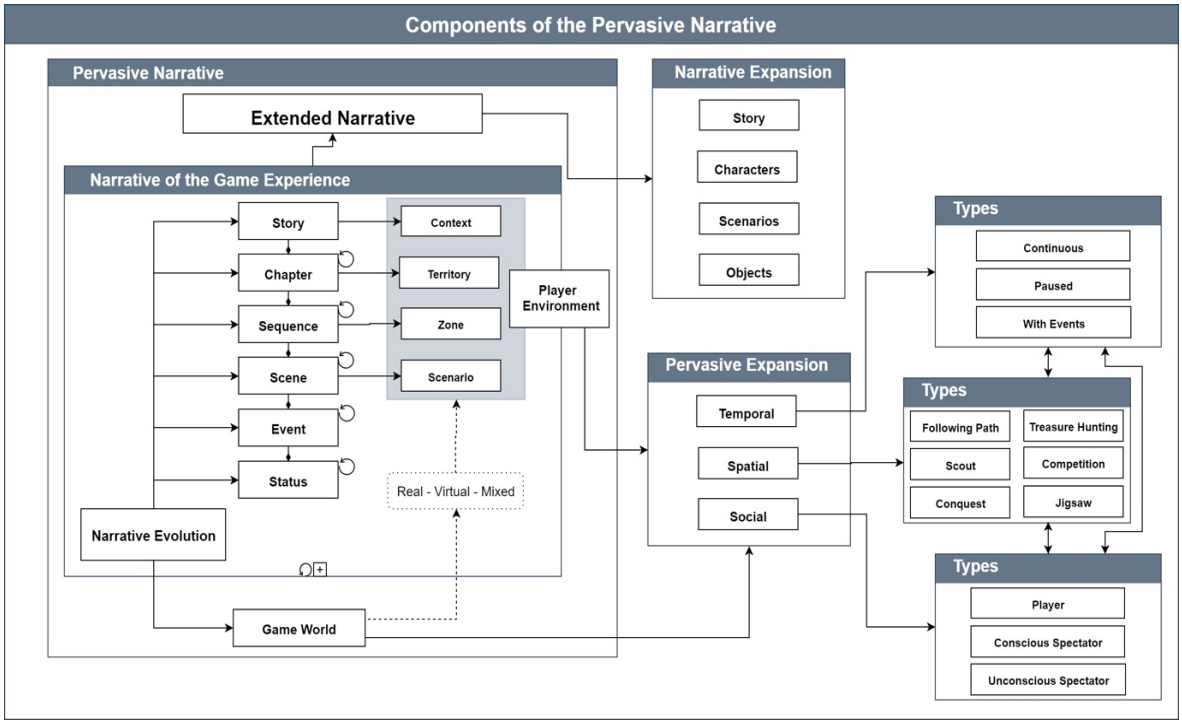

Figure 4 – Components of the Pervasive Narrative.

In addition, two expansions of the narrative are presented. The first one is related to the expansion of the narrative itself, allowing the evolution of the story itself, the characters, the scenarios and the objects. These elements can be modified according to the initial design, and the update of one of them can influence the evolution of the other elements. Secondly, we have pervasive expansion, which is composed of the three main axes of pervasiveness. It shows the temporal expansion of three different types: i) continuous, ii) paused and iii) by events. The choice of one of them depends on the objectives and dynamics of the game. Also, spatial expansion is presented in 6 different ways: i) following the route, ii) scout, iii) conquest, iv) treasure hunter, v) competition and vi) jigsaw. Where each one generates different paths through the real world to achieve the objectives of the game. Finally, social expansion is considered from 3 perspectives: i) player, ii) conscious spectator and iii) unconscious spectator. Regardless of the type of pervasive expansion that is implemented, there will be a direct relationship between the actions executed by the player, affecting the entire pervasive environment.

Game World Design

This phase supports the definition of the reality in which the game will be executed (Figure 5). It is possible to run a PG in the real world, the virtual world or in a mixture of these. To achieve this, it is necessary to rely on technological advances and devices such as robots, beacons, interactive tables, projection walls, location sensors, among others. Specifically, in our research, we considered location sensors as a fundamental component, since geographic locations of user devices are widely used to provide rich user experience in various environments (Yoon, Park, Han, Won, & Hoon Kim, 2016).

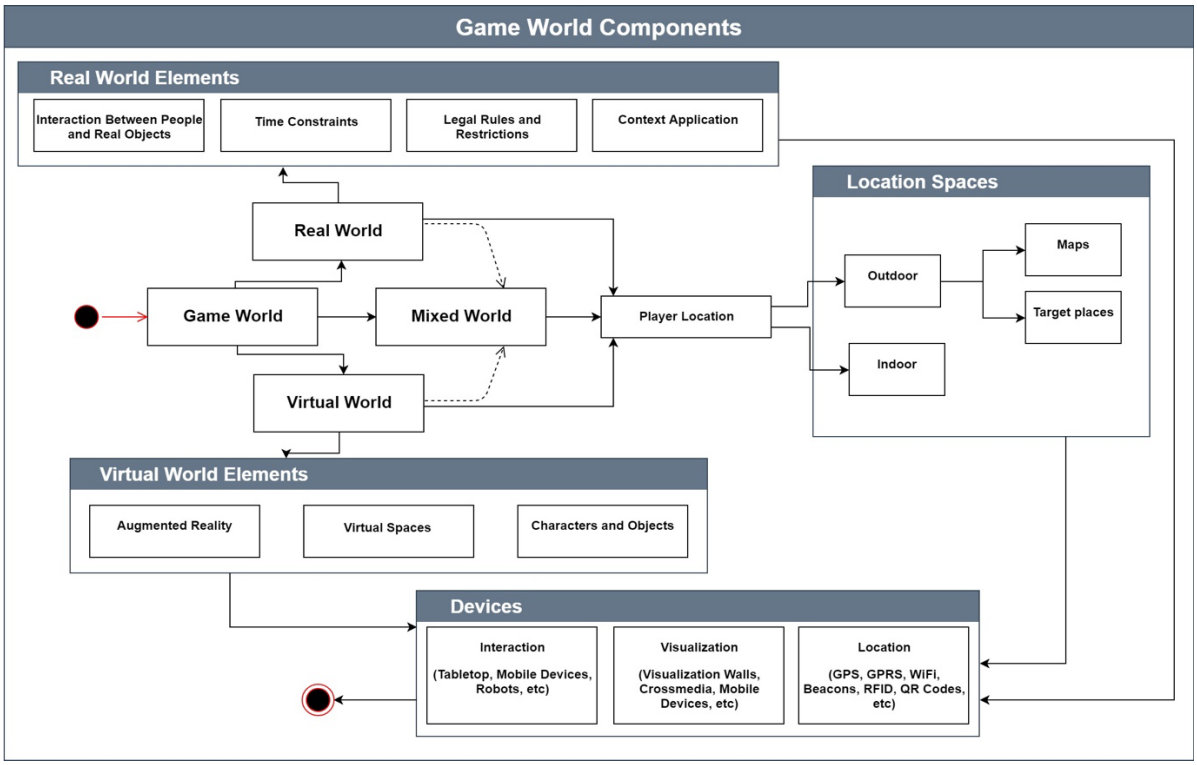

Figure 5 – Diagram of the game world and its components

Traditionally, games have been played in virtual environments, which generate a partial or complete immersion by the players. In our case, we want to bring that experience to the real world, or an interpretation of it by mixing it with virtual elements. For example, in the game Pokemon Go (https://pokemongolive.com/en/), it would be interesting to implement a training module that allows the social interaction of trainers, allowing them to plan encounters in real places and use augmented reality to visualize the training of their virtual characters.

Initially, to understand the Figure 5 is necessary to consider the nature of the game world from a perspective of the realities of the game, as it is important to define the components for each of them. In the case of virtual worlds, it will be possible to include the characters, objects and virtual scenarios where the game will take place. In addition, the technologies to be used must be defined, so that these elements can be visualized by the player and he/she can interact with them. Among these technologies

are augmented reality, virtual worlds, projection walls, interaction tables, sensors, Bluetooth, among others.

In the case of the real world, the components are different, since it is the real environment of the player that must be taken as the basis to define the interaction between him/her and real objects and people. Actions and times must be limited by the rules and legal restrictions defined by the laws of the area or country where the game takes place. Finally, it is important to consider the context in which the game will be developed and the objectives to be achieved.

Rules Design - Gameplay

This phase focuses on the definition of the rules that govern the game. Two types of rules are considered: 1 Static: rules that do not allow modifications during the execution of the game and focus on the limits of the player within the interaction with virtual objects and characters. 2 Dynamics: Non-static rules that can have modifications during the course of the game, besides they can be replaced or removed according to the evolution of the game. Regulations and laws: rules according to the regulations and laws of the place in which the game takes place, since the limits given by each governmental entity must be respected. Ethics: rules that must guarantee the ethics of the people who interact with the game and respect beliefs, races, ages, etc. Moral: they focus on maintaining the good name of places, people, entities, etc., which may be directly or indirectly involved in the game.

Design of the Pervasive Dynamics

As mentioned above, this phase is related to the definition of the UX in the game. The experience can be enriched with dynamism according to the variables of the environment where the player is, presenting challenges or elements of the game according to the values of these variables. Thus, the way in which the challenges related

to speed, temperature, altitude, etc., are presented to the user depends on the state of the environment. In this way, it is incorporated the importance of the GEDD, which contains each of the real and virtual elements that are considered within the game and their interactions. It is also necessary to consider here everything that can happen in the environment of the player.

In GeoPGD, a series of mechanics and pervasive dynamics have been proposed that can be a support for the designer when building the GEDD (these mechanics and dynamics are in Appendix A[1]). These dynamics and mechanics are based on the main axes of pervasiveness. However, they have also been expanded to take into account a pervasiveness of context (focused on broadening the experience of the player to live a role, profession or another aspect different from his daily life).

On the other hand, and due to the need to evolve and give the player new challenges and experiences that generate a high level of motivation and, consequently, feel like continuing to play, it arises the need to have adequate metrics for measuring different sensations that the player may have. In this phase of GeoPGD, it is recommended to use gameplay (González Sánchez & Gutiérrez Vela, 2014), engagement (Brockmyer et al., 2009) and general game experience metrics including In-Game, Social Interaction and Post-Game (IJsselsteijn, De Kort, & Poels, 2013).

4.2.5 Game Experience Design Document (GEDD)

As mentioned above, the GEDD is based on the GDD of a traditional game. However, pervasive and UX components specific to these games are added. This document details the specifications of each one of the phases expressed by the GeoPGD

[1] The appendix A can be found at the end of this paper.

methodology. It explains how it should be generated and provides examples of content for each phase. The format for creating this document can be found in Appendix A.

4.3 Pre-Production, Production and Post-Production Phases.

It is important to note that the pre-production, production and post-production phases are mostly based on iterative activities for each one of their processes. In this way, the need to generate a good game planning from the GEDD is highlighted. This document allows designers and developers to have one document in common. This leads to better communication in the team, positively impacting the results. The relationship between the different activities and artifacts that must be generated from the roles of designer and developer are detailed in Figure 6.

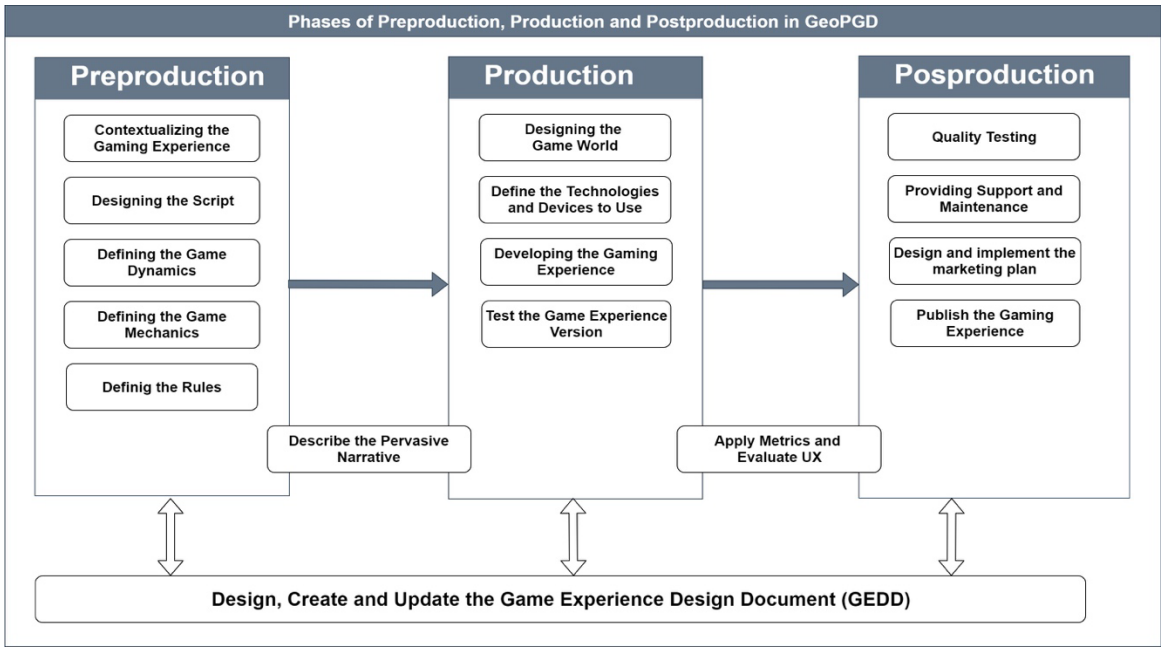

Figure 6 – Adaptation of GeoPGD in the pre-production, production and post-production phases.

Finally, to compare the characteristics of the pervasive games considered in GeoPGD and the other methodologies evaluated previously, Table 1 is presented.

Table 1 – Comparative between characteristics of GeoPGD and other methodologies.

Characteristics / Methodology	GeoPGD	SPEM	Framework for Serious Games	Pre-production, production, post-production.

Pervasive Narrative	Yes	No	No	No
Devices	Yes	No	Yes	Yes
Game World	Yes	Yes	No	No
User Experience	Yes	No	No	No
Dynamic Rules	Yes	No	No	No
GDD	Yes	Yes	Yes	Yes
Iterative Phases	Yes	No	Yes	No

VALIDATION WITH EXPERTS

In order to validate GeoPGD, we have considered the experience of experts in the research topic as a component of validation. Therefore, a validation with experts was designed following the Delphi method (Dalkey & Helmer, 1963; Linstone & Turoff, 1975).

Considering the experience of game development as a whole, academic and industry experts were taken into account. Therefore, it was necessary to ask the questions in these two groups of professionals. However, as we wanted to have divided perceptions, each result was sectioned, being the survey the same for both groups. The Table 2 explains the main sections of the survey conducted to the two groups.

Table 2 – Description of the survey sections and amount of questions for each one.

Section	**Description**	**Questions Amount**
General Information of the Expert	An introduction and explanation of the evaluation is made. The methodology to be used is also indicated and personal, academic and work questions are asked.	6
Definition of PG	No questions asked, it was an explanatory and contextualization section.	0

General Phases of GeoPGD	The methodology is presented in its general phases and questions are asked about those phases.	7
Phases of GeoPGD in detail	Each GeoPGD component and diagram is explained in detail and questions are asked about this.	10
GeoPGD in the form of Preproduction, Production and Post-production	The explanation of the GeoPGD adaptation is done in the context of the pre-production, production and post-production methodology. Questions are then asked about this adaptation.	6
Final Evaluation	Questions are asked about the desire to learn more and use GeoPGD in academic and industrial projects.	3

The first steps were the design of the questions for the validation and the contact with the experts that will carry out the survey. These experts were contacted via e-mail, so that the objective, dynamics and methodology of the validation got explained. The experts who attended the invitation belong to the academy (7 researchers at Ph.D. level) and video game development companies (9 people from the industry).

As it is defined by the Delphi methodology, the review and adjustment phases must be carried out. Therefore, 2 cycles were needed to obtain acceptance by the 16 experts consulted.

In the first phase of the evaluation, the experts gave their opinions and suggestions about what was explained about GeoPGD. The comments and recommendations obtained during this phase were of great help and were valued to make the necessary adjustments with respect to the way to present the phases of the methodology, the terms used in its description and the diagrams constructed in each case.

In summary, the academic experts placed greater emphasis on the formal aspects of the methodology, suggesting changes and adjustments in the diagrams and processes designed and presented by GeoPGD. On the other hand, industry experts focused on the

processes of narrative, communication and documentation. In Table 3 and Table 4 the results of some of the most relevant survey questions are presented.

Table 3 – Summary of the more important results on the survey – dichotomous questions.

Question	**Yes**	**No**	**Analysis**
Do you know a specific methodology for the implementation of Pervasive Games?	0 (0%)	16 (100%)	All experts state that they do not know a methodology for the implementation of PG. This is also supported by the studies carried out at the beginning of the research.
Do you consider the four general phases of GeoPGD to be clear and understandable?	15 (93,8%)	1 (6,2%)	93.8% of the experts consider that the four general phases of GeoPGD are clear in their definition and can be easily understood.
Do you think that the proposed phases are enough for the implementation of a PG?	15 (93,8%)	1 (6,2%)	The experts consider that the GeoPGD phases meet the requirements to develop a PG with all its components.
Do you think GeoPGD considers the special features of pervasive games in its implementation?	16 (100%)	0 (0%)	The experts have defined that GeoPGD covers the special characteristics of PGs in their design and development.
Would you use the GeoPGD methodology in the development of a PG in your research, project or company?	15 (93,8%)	1 (6,2%)	The experts consider GeoPGD to be a very good methodology, which they would use in their industrial and academic projects.
Do you consider GeoPGD's suitability for the pre-production, production and post-production phases to be adequate and correct?	15 (93,8%)	1 (6,2%)	The experts have approved the adaptation of GeoPGD to the pre-production, production and post-production phases. Specifically, industry experts have made very good comments about this process.

Table 4 – Summary of the more important results on the survey – Likert scale questions.

	Response Options				
Questions	**1**	**2**	**3**	**4**	**5**

Please rate the general stages of GeoPGD in terms of clarity and specification. Being 1 very bad and 5 very good.	0	0	1	7	8
Please rate the completeness of GeoPGD and its components in detail. Being 1 very bad and 5 very good.	0	0	3	7	6
Please rate GeoPGD's adaptation to the pre-production, production and post-production phases. Being 1 very bad and 5 very good.	0	0	0	8	8

After this first round of evaluation, the results were analysed and considered individually, for which we took two weeks to generate the modifications, additions and adjustments of GeoPGD components. In this process, the initial diagrams were manipulated. For the second phase of the validation, additional documents were sent describing the GeoPGD methodology, which contained the new diagrams that were improved and standarized. Also, each one of the adjustments made was explained according to the suggestions of each expert.

In this way, this documentation was reviewed and evaluated again by the experts during one week. After this time, we obtained some positive responses that approved the definition and design of the methodology.

DISCOVERING-EAM: AN EXPERIENCE FOLLOWING GEOPGD

In order to apply the GeoPGD methodology, a georeferenced PG called "Discovering-EAM" has been developed. The development of that game was supported by the Geolympus Platform (Berenguel Forte, Pérez Gázquez, Arango-López, Gutiérrez Vela, & Moreira, 2019). This game is an experience that takes new students of the EAM University Institution (Armenia, Colombia) to learn about all the physical spaces of the university. The narrative of the game experience takes place in a space context, where an alien called Ingenium has arrived on Earth and crashed, and his ship has been completely destroyed. For this reason, he has been lurking around the faculties of the EAM, looking for a student to help him get the parts he needs to build a new ship.

When the student meets Ingenium, he/she begins the adventure of collecting the different parts of the ship by meeting challenges that lead the student to tour the different buildings of the university, within which spaces located by augmented reality (AR) markers can be found.

The design of the game experience was embodied in the GEDD. Also, through the storyboard required by the GEDD the objects, characters and narrative of each scene of Discovering-EAM were made clear, and also it was explained how the student can interact with each one of these. Individual characteristics of each challenge, mission or level were also defined. In this same document, it can be found the design of the graphical interface of the game, interaction specifications, and menu options presented to the student.

Following the designs of the graphical interface that was propoesed, scenes have been created for each of the missions. They comply with optimal standards for user interfaces and for the processing potential of mobile devices. Screenshots of a Discovering-EAM mission are shown in Figure 7.

Figure 7 – Screenshots on a mission in Discovering-EAM.

At the end of the game, players had to answer five questions related to their perception of the experience. This survey was incorporated into the game, so it was

quick and easy. 44 response records were obtained from the students. The results obtained for each of the questions are presented in Table 5.

Table 5 – Results of the final survey in Discovering-EAM – dichotomous questions.

Questions	Yes	No
Do you consider that the design of this game experience has been adequate for the activity carried out?	42 (5%)	2 (95%)
Do you think what you learn in this game experience will help you adapt to university life?	42 (5%)	2 (95%)
Do you think the gaming experience has helped you in the process of recognizing the physical spaces of the EAM?	43 (98%)	1 (2%)
Have you been motivated by this game experience to get to know the physical spaces of the EAM?	41 (93%)	3 (7%)
Do you feel like you had fun during the gaming experience?	39 (89%)	5 (11%)

It is important to clarify that the data obtained in the surveys with experts and students are totally anonymous. Therefore there is no chance of identifying the people who answered each of the questions.

7 CONCLUSIONS AND FUTURE WORK

In this paper, the GeoPGD methodology has been presented. This methodology proposes guidelines for the design and development of georeferenced pervasive games (PG) and provides the tools to generate a concept of extended narrative or pervasive narrative. This enriches the game world that is proposed by mixing real and virtual elements through the use of technological devices.

In comparison with the methodologies currently used, GeoPGD includes tools that cover all the components of a PG. This leads to GeoPGD being efficient and effective in the design and development of a georeferenced PG. It is considered that GeoPGD delves into the special characteristics of pervasive expansions to improve the design and development process, generating greater impact on UX and the gaming

experience as seen with the case study of Discovering-EAM. The GeoPGD methodology allows developers to take into consideration new elements that join with new technologies to increase the success rate of the gaming experience.

During the validation process, two fundamental axes have been considered: experts (7 academics people and 9 people from the video game industry) and end users. Firstly, the experts have evaluated each one of the components of GeoPGD, and their suggestions have supported its growth and better specification. In addition, these experts expressed their interest in using GeoPGD in their business and research processes. Secondly, through the Discovering-EAM game experience, end users have been reached in an educational context. In this process, it was possible to discover the interest, motivation and fun generated by a game developed following the GeoPGD phases. The knowledge of the physical spaces of a university was the main objective, and it was achieved according to the students' opinions.

On the other hand, from the experience gained with this research process, it is stated that in the design and development of PG, it is necessary to have an interdisciplinary team, where developers, designers, and experts in the area of application of experience must be present. In this respect, the need for a methodology to guide each phase is evident in order to increase the probability of success. This methodology is not limited to a single context, so it can be adapted to different processes. GeoPGD considers geolocation in closed and open spaces, which allows it to implement experiences of various types. Also, technological options are presented for each of these types of user location.

Additionally, GeoPGD focuses on UX that the user can live through pervasive dynamics, for which it proposes a base catalogue of them. However, depending on the objective they can be modified and extended to achieve it. In this sense, GeoPGD

proposes to evaluate the player's UX by means of gameplay and game experience metrics (In-Game, Post-Game and Social Interaction).

GeoPGD also considers special conditions for players, for which it presents a series of technologies that can be adapted to any need in the narrative process and definition of the game world and its rules, with the goal of providing game experiences that contribute and have a relevant social impact. Finally, as future work we have considered to expand and deepen the areas of study of the PG to implement solutions through GeoPGD. At the same time, these experiences can generate modifications and improvements in the methodology. The area considered for the extension of the research is based on a doctoral thesis it is proposed the implementation of game experiences that allow the detection and improving the communication of children with Asperger's syndrome following the guidelines of GeoPGD.

APPENDIX A

The GEDD and narrative structure formats can be downloaded from the following links respectively: https://goo.gl/c2yM8D and https://goo.gl/Cgvw5G

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ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.