Supporting narrative design in video games: Proposal and case study with an educational video game

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Abstract
Among the elements to take into account when designing a video game, narrative stands out because of its importance and the difficulty of its design. Narrative design in video games is a crucial task, but there are no standard processes for designing interactive digital narratives. Video games with educational purposes is a field with a long story of successful case studies. A suitable narrative for such games is especially important, in order to get the player motivated and captivated by the story, which serves as a vehicle for transmitting and evaluating knowledge. This paper describes a proposal of a narrative design process for video games developed for general application but particularly useful for educational games. The proposal defines a narrative structure, a set of steps for the definition of the narrative, and a set of documents created in the process, each one defining a different point of view of the narrative of the game. In order to validate the proposal, a narrative-rich video game named Time Invaders was designed, aimed at teaching reading comprehension. The game was tested with 237 school-age children, measuring the players' experience and degree of satisfaction. The study revealed that the narrative was the most valued element of the game.

Keywords Video games, Narrative design, Educational software, Multimedia tool.

1 Introduction

There are many different types of video games and many ways to classify them depending on their different characteristics [1]. One such classification is based on the levels of integration of the story with the game mechanics. There are digital games where the mechanics have nothing to do with the story, which is usually a simple contextualization (an example is Space Invaders) whereas there are others games in which the narrative (or story-telling) is the main mechanic of interaction so that the game becomes a way of living an interactive multimedia story. Thus, in the case of adventure games (for example Life Is Strange), the story is completely linked to the mechanics of the game. In this type of game, the player interacts with characters and objects in the scenarios, solving puzzles through dialogues and actions. This integration has an important effect on the narrative: interactivity, i.e., the story integrated into the game can be modified by the player. These interactions generate the narrative progressions that will lead the player to the end of the story. This fact makes it necessary to design the narrative methodically from the beginning and to use technical documents and diagrams to validate the alternative courses of the story.

Narrative in video games has two basic functions: contextualization and motivation [2]. Regarding the former, a video game is a heterogeneous set of multimedia elements aimed at providing a fun experience for players. When designing such elements, one of the most difficult problems is to provide sense and continuity during the game experience. Narrative is usually used to place all the elements in context and to give sense to the game experience. The design of activities such as scene transitions, the appearance of characters, or the sequencing of puzzles, is much simpler if we start from a good narrative. Regarding motivation, the interest provided by the story arises from narrative properties such as mystery, plot twists, emotion generation, creation of uncertainty and conflict resolution, all of which maintain the motivation of players and encourage them to complete the game [2].

What may be described as serious games [3] are recognized as representing a good tool for teaching purposes, since they increase students' stimulation and can enhance their attention and motivation towards what they are taught [3]. Game based learning is a natural way for children to learn since children learn through play from birth. Consequently, it has become a widely used instructional resource in teaching, and particularly in the classroom [3]. Educational games motivate students, provide them with capacities for the creative resolution of problems and

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encourage critical and reflexive thinking [3]. Educational video games possess the advantages identified by various learning theories and provide a means for inclusion, as they favor the principles of presence, participation and progress [4]. Educational games can integrate the information necessary for facing the educational challenges in the voice of the narrator and in the dialogues between the characters and the avatar (explicit narrative), although it is also common to integrate them in the interactive objects and tasks of the game (embedded narrative). It follows that if the narrative is not well designed, the educational objective of the game will not be achieved.

Within this context, the purpose of this paper is to analyze previous works in the scientific literature concerning narrative design in video games, to identify gaps and to propose a process that allows structuring the narrative design in video games, specifically concentrating on the application of the design to serious educational games for which narrative has a great impact, both for the playability of the game and for its educational effectiveness. This proposal is intended to be useful for creators of video games, educational games and interactive products in general to include narrative in their design. In order to test its suitability, the proposal has been applied to the design of an educational video game. The result has been tested in an evaluation process carried out with real users, measuring their satisfaction with the designed game in general and specifically with its narrative.

The rest of the paper is structured as follows: Section 2 discusses the importance of the game as an educational tool and analyzes previous work dealing with narrative design in games in general and in educational games in particular. Section 3 introduces a proposal for narrative design in video games, and outlining the special considerations for educational games. Section 4 introduces the educational game Time Invaders, whose narrative has been designed using the presented proposal, and Section 5 reports on the evaluation carried out to assess the satisfaction of 237 students after playing the game (including satisfaction with the story). Lastly, section 6 establishes some limitations of the proposal and section 7 summarizes the conclusions and outlines plans for future work.

2 State of the art

This paper proposes an approach to narrative design in video games, which is instantiated in a case study that utilizes an educational video game to analyze the feasibility of the proposal, since this type of video game usually contains a strong narrative component. Consequently, the state of the art section addresses the use of video games as an educational tool (section 2.1) and the existing approaches to facilitate the creation of narrative in video games, including educational video games (section 2.2).

2.1 Video games as educational tools

As stated in the introduction, video games are an interesting resource in the field of teaching. The positive effects of video games have been studied for a long time. Such positive effects can be organized around five axes:

1) Physical improvement.

Video games generate improvements in the motor function [5], in the visual function [6] and in hand-eye coordination [7].

2) New thinking abilities.

Video games promote abilities such as abstract thinking, including the comprehension of conceptual models and symbolisms, as well as a better performance in cognitive operations such as classification [8]. Likewise, certain video games produce a strengthening of critical knowledge [5], mathematical and logical knowledge [9], and creative knowledge [3].

3) Obtaining or reinforcement of abilities.

Playing video games generates or reinforces abilities of planning [10], memorization [11], autonomy, cognitive control and decision making [12], language [7], and use of technological tools [8]; as well as a better visualization/spatial representation and comprehension of 3D systems [5] and an increase in exploratory and discovery abilities [5]. Regarding learning abilities, educational video games favor the self-regulation of learning [4], problem-based learning [13], and participative learning [9].

4) Positive effects in attitude and emotional state of the player.

Video games generate motivation and curiosity towards learning [4], improvement in concentration and attention [13], and improvement in self-esteem [5]. Also, video games produce emotional reactions [14] that can be used to

enrich the ludic part of the game but also the educational part from a user-centered point of view.

5) Opportunities of social interaction and collaboration.

Video games have positive effects in social abilities [8] and psychosocial abilities [15], and also in the ability to participate in group work.

In spite of the reported positive effects, adverse effects have also been detected [16]. These adverse effects are frequently related to the use of commercial video games, not specifically designed to educate, or by the use of poorly designed video games, generating boring games or games with low educational content.

The design of an educational video game is a complex task in which a heterogeneous set of pieces must be assembled. Those pieces are the educational goals, the set of tasks proposed in order to achieve them, the rules of the game, the ludic goals and the rewards associated, the way in which the educational evaluation is carried out, and, the story that contextualizes the game making use of characters, scenarios and objects, among other elements. Moreover, it is important to perform this arrangement in a well-balanced way so that the two main goals set out are accomplished: the use of the game as an educational tool on the one hand; and the use of the extra motivation generated by the game in order to maintain the interest in students on the other hand. We already proposed this in a previous methodology for the effective design of educational video games [17].

Taking into account the difficulty of designing an educational game, there are many scientific proposals that try to make it easier and consequently improve the quality of the final product. However, it is frequently difficult to select the solution that better fits our specific requirements, as the availability of such proposals lacks organization. Thus, with the aim of ordering and classifying these proposals, in this work we organize the state of the art relating to educational video games design around three axes (see Figure 1): level of abstraction, purpose, and focus.

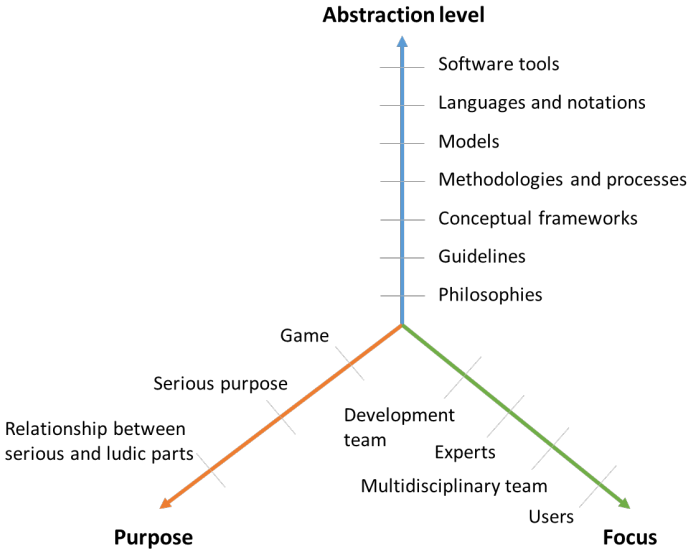

Fig. 1 Three axes system to organize the existing approaches for the design of educational video games

If we move through the vertical axis in Figure 1, we will find some approaches for the design of educational video games with very different **levels of abstraction**. In the higher level of abstraction, which is symbolized as nearest the intersection of the three axes, we can find the philosophies and reflections that try to catch the essence of the design of an educational video game. This is the case of the TGD (Triadic Game Design) approach [18], which stresses the importance of balancing three worlds: reality, meaning and game. These approaches are followed in this axis by the guidelines that plot the path to follow when designing certain elements in serious games. Some of those guidelines are formalized as design patterns, as is the case of the patterns for video games proposed in [19], the pedagogical and design pattern for educational video games used in LM-GM (Learning Mechanics-Game Mechanics) [20], or the level design patterns for 2D video games collected in [21]. Advancing in the axis, we find the conceptual frameworks, which constitute the theory that lays the foundation of the design of the educational video game. As an example, there is the theoretical framework for the design of serious

educational video games [22] where video game, pedagogy and fidelity are integrated. Fidelity is defined as the degree to which the video game emulates the real world. Another example is the Context Learning Game (CLG) framework [23], which defines three hierarchical stages: context, learning and game. The context stage establishes the general aspects of the game, such as objectives, audience and available resources. The learning stage defines the components of formal learning, such as learning theory, content, objectives and learning activities. And finally, the game stage covers the formal elements of the game, development and testing. With a higher level of detail, some methodologies and design processes for educational video games have been proposed in order to establish the set of stages, procedures and techniques to apply during the design. Some well-known examples are the Emergo methodology, based on ADDIE (Analysis, Design, Development, Implementation and Evaluation) [24], and the 5M methodology (Method, Milieu, Manpower, Machine and Materials) [25]. The following proposals in this axis are the design models that formalize the elements that an educational video game must have and their relationships, giving rise in certain cases to full architectures. An example in this sense is the proposal in [26], where educational, ludic, interrelation, user and group models are put together. Other authors define languages or notations, or adapt some existing ones to make easier and direct the design of the educational video game. For example, in [27] the authors make use of XML. At the same level, we find XVGDL [28], a XML-based Video Game Description Language which allows using artificial intelligence to optimize a given game. In other approaches, graphical notations are used, such as UML [29] or Petri nets [30]. Lastly, in the lowest level of abstraction we can find the software frameworks and tools that support the design of educational video games. Within these, we may mention the e-Game project [27], which makes easier the design and development of educational adventures by means of an engine that is able to generate functional applications starting from a set of documents created according to a pre-established XML-based syntax. Another example is the e-Adventure platform [31], which offers a relatively simple and intuitive authoring tool for use by teachers.

The left axis in Figure 1 shows the dimension of purpose, representing whether the design is intended for a) the ludic dimension of the video game (in this sense, fun is a recurring concern), b) the educational dimension of the video game (the generation of content, resources and tasks on a multimedia basis), or c) the proper integration between both dimensions. As the balance between the ludic and the educational dimensions has been identified as a critical aspect for the success of this kind of software [22], in recent years this purpose has been pursued with a wide range of levels of abstraction: from guidelines for the balance between ludic and educational dimensions found in [32], which follow a holistic point of view, to the model-based software architecture for collaborative educational video games proposed in [26]. In all cases, narrative will be an important additional factor in achieving this ludic-educational balance.

Finally, the right axis in Figure 1 relates to **focus**, understanding this as the group of people within development who are the focus of attention: a) the development team; b) the team of experts who have the knowledge about the purpose of the video game (teachers, educators, school counsellors and other educational experts); c) the multidisciplinary team that combines the previous two; or d) final users of the educational video game (mainly teachers, students and parents). At this point, a good level of communication among the members of the multidisciplinary team has proved to be a critical element. In this respect, it is a reality that educators face numerous challenges or barriers when designing, developing and implementing educational games [33]. In order to assist this communication, some approaches propose the use of ontologies [34], graphical notations [29] or authoring tools [27] [31]. Lastly, there are also user-centered design approaches based on the premise established by Schell [35] that states that the video game is made for the player. An example would be the approach in [36], where the authors call attention to the fact that preferences and differences of learners must be considered from the early stages of the development of the serious educational video game. In order to achieve this, the authors use a conceptual framework with four dimensions: context, specification of learners, pedagogical considerations, and way of representation.

2.2 Designing narrative in video games

The development of a video game involves a broad set of elements, and the number of tools and techniques that can be used for its design is even broader. In the specific case of narrative, the problem is similar, and possibly even more complicated [37]. The lack of standard processes for designing interactive digital narratives represents a significant obstacle for designers of this kind of multimedia tool, mainly for those who are novices in the field

[37]. As Koenitz states, there are not enough proposals in any of the three categories in which we can classify the process of creating interactive digital narratives: 1) high level abstract descriptions, which simply provide generic recommendations for the design of narrative; 2) dichotomous approaches, which take narrative as an antagonistic element for the design of the game; and 3) descriptions of the design of specific works, which make it impossible to reveal generic processes. There is therefore a gap which this research seeks to address.

In the case of video games, most authors are in the first category (high level abstract descriptions), where some interesting generic recommendations are established. These include the following: the narrative can be used as a reward, unveiling parts of the story to the player as he/she reaches the goals of the game [38]; the narrative can be used to adapt the story to each type of player [39]; the narrative can be used for having the player identified with the main character through the emotions that arise throughout the game [40]. In [41], a systematic review analyzes the importance of narrative in serious games and establishes the characteristics that a narrative must have to be effective from the 44 papers analyzed. These characteristics are: a) distributed narrative (the narrative is not located in one place but rather is distributed across the interactive learning environment through the environmental storytelling); b) endogenous fantasy and intrinsic integration (the fantasy supports intrinsic motivation, especially when the fantasy is intrinsic to gameplay); c) empathetic characters and virtual agents (when creating characters for serious games, one challenge is to achieve empathy between the player and non-player characters. This empathy can influence the player's decisions.); and d) adaptive and responsive storytelling (students/players may also be more attracted to stories that are personalized for them).

The review in [41] concludes that two proposals are the most relevant in the opinion of the authors: the technique GDA (Game Discourse Analysis) [42], which uses foreshadowing and a back story to manipulate the flow of information in a way that promotes curiosity about what will happen next in the game, and the framework NCID [43], a narrative centered informant design process for designing educational games. GDA [42] consists of three components. The first focuses on the elements of the information flow, i.e., on the analysis of the information resources needed to perform the tasks in the game. These information elements are classified in actions, events, objects, perceptions, and internal responses. The second component defines the concrete blocks of information for each task and creates semantic relations among them, generating the flow of information. The third component creates the discourse for each scene, instantiating the narrative in the corresponding subflow of information. The proposal is interesting but the creation of the flows of information can be tedious for authors and this is identified by the authors themselves as an aspect to be improved.

Waraich's NCID [43] process is specific for educational games and is based on the use of the learner centered Informant Design (ID). The process establishes four phases: 1) defining the domain and problems and identifying basic narrative elements; 2) defining plot and characters; 3) designing and testing low-tech materials; and 4) designing and testing high-tech materials. The approach relies on close cooperation between designers and informants to ensure that the system that is developed meets the needs of the learners. It is an interesting work but it does not fully address the process of writing and structuring the narrative, but rather the process of cooperation between the different stakeholders to extract the key information to create the story.

Other authors have focused on classifying the different types of game narratives. For example, Jenkins et al. [44] differentiate between: a) evocative spaces, where the narrative tells a well-known story that helps the user to remember something, but which cannot be navigated; b) enacting stories, which emerge during the game so that the player interacts and consequently drives the story forward; these can be spatial stories –stories that are active throughout a series of scenarios with the focus on achieving certain goals- or micronarratives –stories that appear occasionally and are used to generate a high emotional impact in a scene-; and c) embedded narratives, which are integrated in the scenarios and objects of the game, providing clues or other kinds of significant information with which to understand the story and solve puzzles. Another example of classification is the work described in [45], in which the author classifies based on the degree of narrative that the game has, from the lack of story to a situation in which narrative is everything and thus the solution of the game depends on the story. Similarly, in [46] a simple classification is defined, differentiating between story event-based narrative (narrative as a series of events); game scenario-based narrative (narrative is constructed by players); structuralism-inflected narrative (players' actions are embedded in the narrative); and cognitive psychology-based narrative (narrative as a mental tool whose starting points are story events). Finally, in [47] the following structures are identified according to the flow of the narrative: a) linear narrative, where the stages (onboarding, late onboarding, midgame late, midgame, endgame and

everlasting experience) follow one after the other; b) multilevel linear narrative, the same as the previous one but having the midgame element divided into different levels; c) branching narrative, allowing different endgames according to decisions taken during the gameplay; d) parallel paths, with parallel paths falling into the same endgame and everlasting experiences; and e) dynamic narrative, with narrative elements dynamically created with the real risk of deviation from the game goals.

Finally, some authors have sought to identify more specific mechanisms to introduce narrative in video games. For example, in [48] the authors establish a difference between those games where players' actions drive the course of the story and those where the player cannot have an influence in the story, which would be the same irrespective of his/her actions. In the first case, the narrative flows with the actions and abilities of the player, and the quality of the story is changed according to this. In this respect, some works focus on narrative serious game mechanics, such as the work described in [49]. Here, it is established that narrative allows the building and deconstructing of the time and space of events following some narrative-pedagogical mechanisms such as exposition, which introduces a starting point for the development of events in the story, the narrative guide, which drives the player to explore a game space or to interact with other players, and reflection, which provides feedback that is essential in the learning process, as well as understanding whether the actions carried out in the game have been correct or wrong.

In conclusion, in accordance with the statement by Koenitz [37], we can state that all these proposals move at the conceptual level but do not sufficiently detail the process of structuring the narrative that is fundamental in most educational games, where the degree of narrative must be high to encourage the curiosity and sense of challenge that will promote the learning implicit in the game. Consequently, we propose a structured process for narrative design in video games, which covers all the necessary tasks, both conceptually and technically. The proposal is located at the midpoint of the vertical axis in Figure 1 (methodologies and process) and is explained in the following section.

3 Narrative creation process proposal

The proposal presented in this paper to design narrative in video games is divided into three interrelated components: a narrative structure, a narrative process, and a set of narrative documents generated as a result. The narrative structure divides the plotline in four levels (chapter, sequence, scene and event) and the scenarios in two (zone and region). The proposal then connects all these elements with the characters of the game, defining the narrative evolution of the game (independent of player interaction). This structure is the basis of the proposed narrative process, which is divided into eight steps generating seven narrative documents. The narrative structure allows the principle of divide and conquer to be applied when approaching the complex process of defining the narrative of a video game. Following this approach, the narrative process executes the global task in incremental and iterative steps, which allows the problem to be addressed in cycles until the final narrative is reached. The set of technical documents generated during the process enables developers to implement the video game without ambiguity regarding the narrative.

The process can be used by any designer/developer that wants to develop a game or any kind of interactive multimedia tool in which narrative plays a role, although it is especially useful for games with event-based narratives and a strong narrative component. As already stated, narrative is a very important component in many educational games and it needs to be properly defined in order to achieve the required educational goals. For this reason, our proposal has taken this type of game into consideration from the beginning. For instance, structuring the story into levels will allow educators to plan educational challenges also by levels, moving from general educational objectives (in the chapters, for example) to specific educational tasks (associated with specific game events in a scene). These educational items can be listed and later added to the story structure document so that they can be linked to the different actions in the story. It will therefore be clear how those educational goals are addressed and evaluated in the game, which facilitates the study of the appropriate play/educational balance. It should be kept in mind, however, that the proposed narrative design process is general, and therefore does not rely on any one learning theory, nor does it focus on how the narrative produces learning outcomes.

Sections 3.1, 3.2 and 3.3 describe each of the three components of the proposal (structure, process and generated documents), while in section 4 an educational game is designed using the proposal.

3.1 Narrative structure

One of the first challenges when creating an interactive narrative is the need to design a strong structure for the story. This is due to the fact that the process of interaction with the player must allow the story to evolve in several ways, making the player feel that his/her decisions are driving the story and not the opposite, which greatly complicates the representation of story. In order to carry out such a structure, we start in our approach from the concept of event as the basic element of the interactive narrative. We define event as *each player's action that causes a change in the story*. Some events will come before others in the story, and sometimes the player will be able to choose, in a more or less direct manner, which event will happen after another has taken place. This possibility of choice or fork in the story can be modeled by means of a directed event graph. At the story level, we can say that the player's events will cause a narrative evolution. The player lives the story as a sequence of narrative evolutions that give rise to his/her game experience and that are associated to the narrative structure by means of a plotline. Due to the high number of events in any video game, it is essential to provide an explicit structuring mechanism.

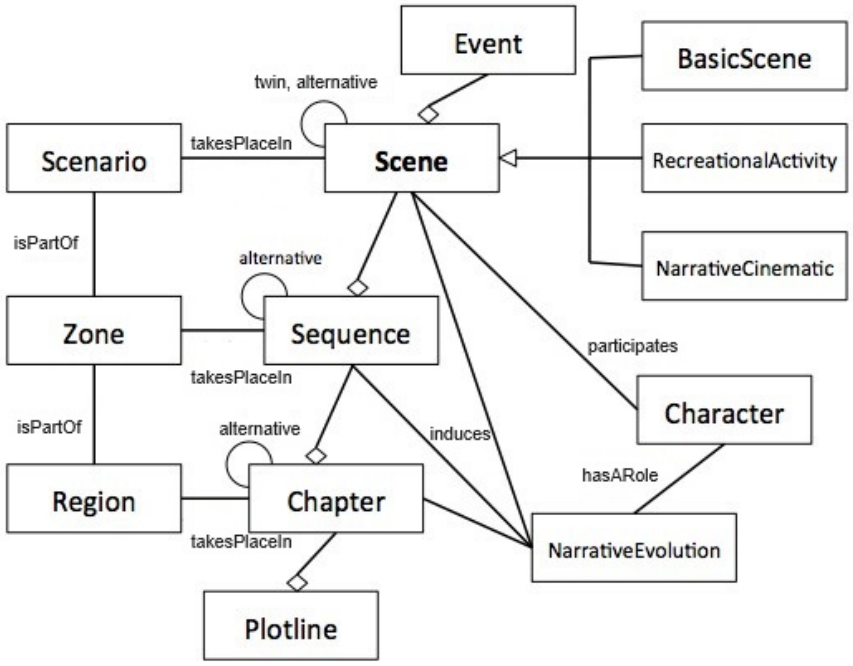

Fig. 2 Narrative structure in video games [17]

Figure 2 shows the full formalization of the structure included in our proposal, previously defined in [17]. As can be seen in the figure, a set of related events that happen in the same place make up a scene (the basic scenes are those that have an impact on the outcome of the game because they present challenges necessary to advance in the game; but there can also be narrative cinematics and purely recreational scenes). In the same way, a set of related scenes make up a **sequence** (not all scenes related to a sequence necessarily have to be executed, as there are alternative scenes that will or will not be played in the different game experiences). **Scenes** in a sequence are developed in scenarios belonging to the same **zone**. A set of sequences is a **chapter**. And, lastly, the set of all the chapters make up an ordered structure: the story of the video game. We have defined the concepts of scenario, zone and region in order to allow interchanging scenes and sequences in different parts of the story, but without losing the coherence of the characters and landscape. The dynamic interrelation of all these elements gives rise to the narrative evolution during the game.

This hierarchy allows working on the story at different levels of abstraction. Without any hierarchy, a division of the story in specific happenings would produce a very wide and complex graph that would be difficult to handle. In contrast, dividing the story in bigger sets of happenings would produce easy to handle graphs, but control over

small actions in the story would be lost. The concept of hierarchy helps to take control of the story at all its levels without increasing the complexity of its management, as the different parts of the story become encapsulated in structures at different levels. In order to organize components in the storytelling, our model includes a dictionary containing an entry for each of the previously described elements which stores the name of the elements utilized in the scene, sequence or chapter specifications. This allows the integrity and references between models to be maintained.

3.2 Narrative process

Taking the structure described above as a basis, we propose in this paper an iterative process for the creation of an interactive story. Using this method, it is possible to carry out consecutive versions towards a final solution. At this point, it is necessary to clarify that designers should think about the narrative from the beginning, because the mechanics are designed to outline the narrative; so it would not be a good idea to try to place a narrative in a preexisting structure. During the application of the proposed process, diverse documents and products that help the author to build the story in an incremental way will be generated. The goal of the narrative process is to make the creation process of a high-quality interactive story easier and to make it available for developers of interactive products that aim to add story to their product during the design stage, and to writers working on an interactive story or teachers designing educational interactive products.

The proposed eight-step process can be applied to the whole story being created as well as to specific parts of it. This means that after the iteration over the whole story has been carried out, some independent iteration can take place applied to each scene, sequence or chapter, depending on the specific characteristics of the project. The steps to be carried out in each iteration of the process are depicted in Figure 3 and described below. Given that the case study conducted in this article relates to an educational video game (section 4), and the fact that educational video games tend to be inherently narrative, some considerations are made at each step of the narrative process for this type of video game. Obviously, if the video game being developed is not educational, these considerations would not apply.

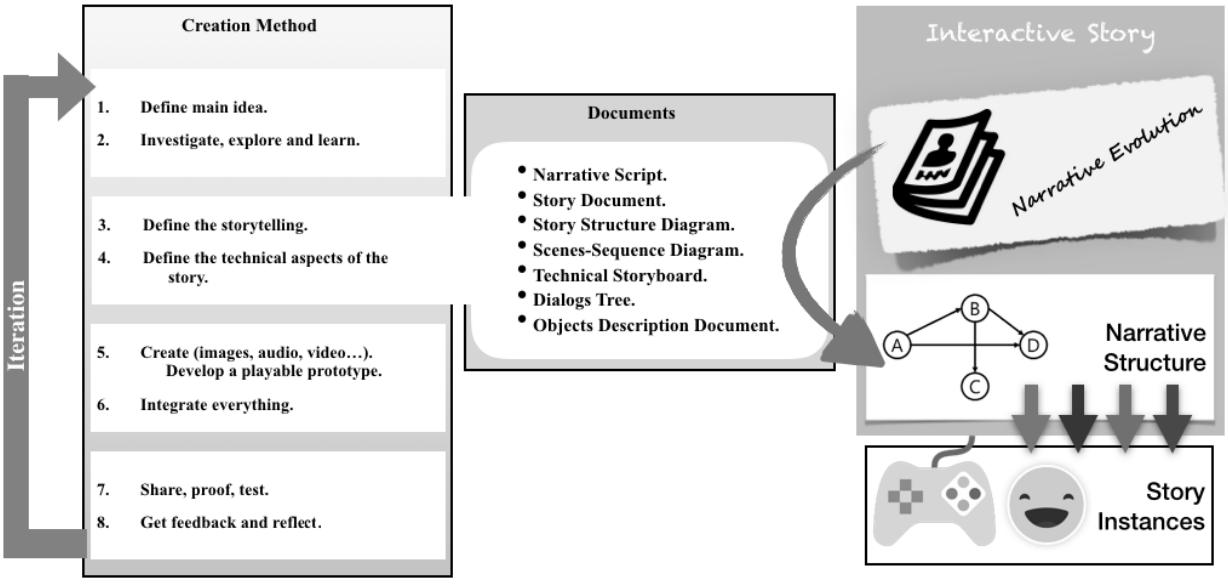

Fig. 3 Interactive narrative creation process

Step 1. To define the main idea. As shown in Figure 3, the first action to perform in each iteration of the process is to define the main idea of the story behind the game. In this phase, the main elements of the story are considered: the objectives, target audience, type of game console/device, game genre, game world, main characters and levels.

With this initial conception in mind, designers think about what narrative story they want to include in the game. An event-driven narrative approach will be followed and therefore the primary events of the story should be established in this step. It is important not only to think about the theme, plot and main events, but also about the form of the narrative: whether it should be embedded or explicit, third-person or first-person, and whether it should include dialogues, micronarratives, and/or spatial narratives. For an educational game, it is very important at this stage to understand the learning goals and outcomes, and then develop a suitable narrative that supports these goals. The most important aspect of educational goals is the learning outcome. Narrative is a vessel to achieve this goal in the most engaging way possible. Therefore, before coming up with a story, the designer needs to understand the learning purpose and outcomes.

Step 2: To investigate, explore and learn. Having decided on the main idea, a process of investigation and exploration should be followed. These actions are carried out before defining the storytelling. This step is essential and cannot be skipped, as one of the most serious risks is that the initial story idea becomes so firmly established that it resists modification and change when it may prove not to be the optimal choice. User-centered design techniques should be applied at this point, where alternative scripts are analyzed by potential players and experts to see which has the most narrative strength. In addition, if the game has an educational purpose beyond entertainment, it is essential to analyze whether the story allows implicitly integrating the educational objectives and their evaluation. In this creative process, the story is improved and specified iteratively. In this step, the search for and collection of information necessary to create coherent game worlds will be carried out. In addition, literary techniques can be used to successfully create an engaging story, throughout all its parts: introduction, development, climax and conclusion. Furthermore, the main characters are re-considered at this step, defining well-developed characters with clear motivations and emotional depth whenever necessary.

Step 3: To define the storytelling. In this step, the objective is to structure the narrative that has been outlined in the previous steps. Specifically, the definition of the storytelling involves creating the narrative script, the story document and the story structure diagram. To do this, the focus is on the events of the story, although these will obviously take place in scenarios and will be "performed by" and/or "have an impact" on certain characters. The structure shown in Figure 2 ensures that the story is well structured from a technical point of view. However, it is not enough for the story to be well structured. The story needs to be interactive and dynamic. Therefore, in the first place, it is important to design meaningful decisions that affect the development of the plot and the fate of the characters, which will allow players to feel that they are an active part of the narrative. In second place, it is important to include multiple ramifications in the story, allowing players to take different paths and experience different conclusions. If the game has an educational purpose, it must be ensured that the educational objectives are achieved in the different paths of the game. In addition, in the case of educational games the designer must be continually careful to maintain a balance between the enjoyment of the game and the learning content. A lack of balance in the game may risk generating a cognitive overload that is not advantageous from a learning perspective.

Step 4. To define the technical aspects of the story. Once the storytelling is available, it is possible to define the storyboard and the remaining technical documents which represent a starting point for creating the multimedia resources of the game that are necessary for the narrative: images, audios, videos, music and sound, which will be created in the next step. Traditionally, the storyboard is a set of images arranged according to a narrative, where the illustrations are presented sequentially to preview the structure of the story. In this case, the storyboard will not be sequential, in order to reflect how the story branches through the player's interactions in the game. The task of creating the storyboard can be assisted by one of the many tools that exist for this purpose. The important point is to identify every possible interaction and detect parts of the story that may need more detail. Specifically, during this step the scenes-sequence diagrams, the technical storyboard, the dialog trees and the objects description documents are created.

Step 5. To develop a playable prototype. In this step, the multimedia resources of the game related to narrative are created. Using artwork, the narrative elements that make up the game are graphically displayed, as well as the design of worlds, scenarios and characters, establishing a visual style that will serve as a guide for the entire visual development of the video game. A good practice in the first iteration is to use step 5 to create a small playable prototype created with low-cost resources. This would allow completing steps 6, 7 and 8 using the prototype, that is to say, integration (step 6), sharing and testing the prototype (step 7), and obtaining feedback (step 8). This will also allow us to improve the artistic part and the gameplay.

Step 6. To integrate everything. While the previous step concentrates on the creation of the multimedia elements of the narrative, this step focuses on the integration of all these elements within the narrative structure of the game. The narrative points are created and the corresponding multimedia resources are associated to them.

Step 7. To share, proof, test. The prototype created in steps 5 and 6 are shared with potential players and professionals to analyze the narrative structure and its power to motivate the player, the ability to promote the educational purpose of the game (if this exists) and the viability of all the game paths. Conducting intensive testing will help identify areas for improvement, adjust the difficulty of interactions and decisions in the game, and ensure the story is coherent and exciting. Also at this stage, tests will be conducted to check if the narrative and gameplay are consistent. The challenge is for the playable elements to fit naturally into the story, so that both narrative and gameplay elements reinforce each other. In the case of educational games, this combination (narrative + gameplay) should generate the expected learning outcomes and therefore this must also be tested.

Step 8. To get feedback and reflect. In the last step, a plan is designed to improve the narrative structure of the game in the next iteration (step 1 starts again) until reaching the final version. Although beginning again at step 1, logically new decisions do not have to be made or changes made at all stages. In each new iteration, the changes will be more and more specific, and will mostly affect steps 3 to 6 of the process.

Finally, as shown in the third block in Figure 3, we can establish three different forms that the story adopts during the design process and its further use by the players:

- Narrative evolutions: what happens in the story over time. This is described in the narrative script and in the story document. It can be said that this is the part of the story that is independent of the specific way in which each player is going to live the story during the game sessions.
- Narrative structure: the structuring of the interactive story that is needed for its management and implementation. This is defined in the story structure diagram and in the scenes-sequence diagram. Most of the effort required when structuring the story is devoted to being able to manage the difficulty in the design resulting from the interactive component of the game and the integration with the mechanics.
- Story instance: the story that the player receives at a given moment in the game. That is to say, among all the possible stories that may arise from the narrative structure that has been designed, the specific actions of a player will generate a specific story instance. The technical storyboard, the dialogs tree and the object description document define the specific rules for carrying out the implementation of the game and for generating the different story instances.

Each one of the documents generated and used during the application of the process are explained in detail below. However, at this point it should be noted that the differentiation of the three views of the narrative is an important contribution of the current paper, since it allows the quality of the narrative to be analyzed separately in each of the three identified dimensions.

3.3 Narrative documents

As shown in Figure 3, seven main documents are generated during the proposed narrative process. The documents are described below. Some examples are presented in section 4.

Document 1. Narrative script. The narrative script is the first document generated, which contains the initial description of the dramatic idea. It describes the story, as well as its initial plot, including actions and characters. It is made up of two important elements: the plot –a concise narration of the full story- and the synopsis –both the simplified and full development of the plot. The storyline described in this document is defined through the concepts of theme, plot, characters (and their universe), time, space and meaning (what is aimed to be transmitted). The various evolutions that the story can take are described in this document. The drafting of the document must take into account the genre of the game and the game mechanics to be used, the types of challenges to be set out, and the initial structure of the levels of missions that the game will contain. The information included in this document will provide an initial vision of the game to be developed. During the development, this information will be included in a Game Design Document (GDD) and will be expanded with all the elements that have an effect in the story and its integration with the game mechanics. In the case of educational games, the objectives and expected learning outcomes of the game will have been kept in mind when defining this first narrative script and will be noted in this document.

Document 2. Story document. This document is an extension of the narrative script. In this document, the story

is described in the form of a script divided in scenes (basic narrative structures). It includes the narrative structure of the story, as well as a more or less sequential order of the important events that happen to the characters. We start from the description of the plot and the synopsis after which the treatment of the script is added. That is to say, we incorporate the actions performed in each scene, the description of the scenario and what it includes, characters, dialogs, and music and sound, so that it becomes a sort of classic literary script. In order to reduce the complexity of the document, we propose the use of various documents following the structure aforementioned, so that one document can be created for each chapter, zone or region. Therefore, in the story document, at a game level, one can find the description of what happens in each scene, the characters, and how the player will be able to interact with them and with the environment. As the story is an interactive one, the document must include the different options or narrative lines that depend on the player's actions and decisions. Here, in order to get an idea of each scene in a graphic format, we may draw an initial sketch of the scene in which the main elements are depicted as they will be seen on the screen. For educational games, the educational impact of user interactions with the game that have been designed to generate learning will also be noted in the story documents. This allows checking that all the educational objectives are being addressed.

Document 3. Story structure diagram. As already mentioned, the aforementioned story document must describe the interactivity of the narrative, in other words the different modifications that the story will undergo as a result of the player's actions. To support this technical description of an interactive narrative, a story structure diagram is developed. This diagram is made up of a set of directed graphs where the parts of the story are depicted as nodes and the chronological relationships among those parts are modeled as arcs. In this way, one part of the story can take place before many others, and it will be the player who decides while playing the game which parts take place and in what order. Each graph is built at a specific hierarchical level. Thus, there will be a first node of the story in which each node will be a chapter. Each chapter will be depicted with another graph, made up of sequences. Each sequence will involve a graph with scenes, and a scene will define a graph with events. This hierarchical structure makes both the writing and management of the scenes easier. Furthermore, it allows working more easily with the story in the implementation and evaluation phases. It is usual to design several levels of interaction on the story over time. This implies that in a first phase, the basic story is introduced with few possibilities of decision by the player. Then, argumentative branches start being introduced, giving more freedom of action to the player. It must be remembered that narrative in a video game has to be closely related to the mechanics and dynamics that have been added by the level designer. Thus, these story structure diagrams will be updated by adding narrative elements in order to give meaning to the mechanics of the game. At this level, if the game is educational, the learning objectives that are worked on or assessed in each event, and even how they are assessed within the game, must be noted on the diagrams. For this purpose, the educational objectives should be broken down into educational competences as specific as possible, which should be numbered and identified to facilitate their mapping onto the graph. By having the educational progress associated with the game events, it is possible to monitor whether the necessary balance is being achieved between the educational part and the recreational part of the game (for example, if there are too many recreational challenges, if the game is boring or if the educational part is too obvious).

Document 4. Scenes-sequence diagram. This diagram represents a story technically in a visual format, and is very useful for further implementation. The diagram represents the game space, that is, the set of scenarios in which the player carries out the game experience. The scenarios are depicted graphically, together with the manner in which the scenes are interconnected and with how the player can visit them according to the story defined in the story document and to the events that the player selects. Thus, the diagram includes the definition of scenarios, scenes and transitions between scenes and between sequences. These diagrams are closely linked to the story structure diagrams and are used by level designers for the design and generation of the scenes of the game.

Document 5. Technical storyboard. The technical storyboard is a graphical description of each scene, including schematic drawings of the scenes. On the basis of the scenes-sequence diagram, this storyboard is created. It includes all the elements in the technical script (scenes, characters, dialogs, objects, music, sound, transitions between scenes and technical observations).

Document 6. Dialogs tree. Dialogs are used not only for the interaction with the characters, but also for introducing new challenges and puzzles to achieve the goals of the game, and for providing clues to reduce their complexity. The story at many points advances throughout the dialogs which may act as puzzles when the player

has to select the proper dialog depending on the situation of the story. Given the player's interaction and the need to provide different ways of telling stories, dialog options can reach a high degree of complexity. It is therefore necessary to design a tree structure that shows the different options for each dialog sequence. There are various tools for the design and digital representation of dialogs. Dialog management tools are used to generate configuration files that can be imported into the environments for video game development. In educational games, dialogues are often used to produce or evaluate learning. As in the case of events, this should be noted on the dialogs tree. It is advisable to define the evaluation formulas in as much detail as possible, in order to facilitate their implementation at a later stage.

Document 7. Object description document. This last document describes, for each scene, the objects that appear in it. The description of each object includes some rules that describe how the state of the object is modified when the player applies some actions to it.

4 Case study: designing the narrative of a video game to improve reading comprehension

Following the aforementioned proposal, we have designed and developed an educational graphical adventure game named *Time Invaders*. Its main goal is to allow primary education students to practice reading comprehension. The development of this game and its evaluation have served as a case study in order to analyze the usefulness of our proposal, since the success of the game depends, to a large extent, on the narrative, which integrates educational challenges disguised as recreational challenges. This section is divided into two subsections: the first deals with reading comprehension (the learning goal) whereas the second addresses the game itself.

4.1 Reading comprehension

One of the most important objectives in teaching in primary schools is to teach children to read and understand what they are reading. The competences achieved in reading comprehension are transversal and essential in the educational process at any level, from primary school to university. One of the most common problems within the educational context is that students do not understand what they read and do not understand what they are being asked. Therefore, it is essential to work on the competencies associated with reading comprehension. In [50] five types of competences related to reading comprehension are distinguished: Literal (to locate explicit information or content), Inferential or Interpretive (to make inferences from implicit information in written texts), Critical (to relate the contents of the texts with one's own ideas and experiences), Global (to understand the whole meaning of a text, understanding the meaning of each part and their relationships), and Meta-understanding (self-regulation of the comprehension process). In [51] a set of characteristics associated with reading comprehension are described and the authors comment that there is a variety of accessible online resources so that children can practice it. However, these resources are often unattractive for children since they are usually web pages with exercises specifically created to improve reading comprehension and where, through the use of a computer or a tablet, the children are trained in the same way as with conventional exercises on paper (without interaction).

One of the biggest difficulties detected during the reading comprehension process is attention deficit [52]. The child gets distracted, does not pay attention and does not reach an adequate level of comprehension while reading. This can be mitigated through the use of educational video games that attract their attention and whose narrative is constructed in such a way that the coherence of what is being read is not broken. Kendeou et al. [52] state that "readers' attention allocation when reading can be improved by implementing activities that direct attention to the important or central information in texts and by practicing the detection and repair of coherence breaks".

As an initial step in our research related to the support of reading comprehension through video games, we studied the use of video games designed especially for this purpose. It became clear that there are few concrete initiatives in this regard. Specifically, in [53] a study is described on how to represent a text and its influence on reading comprehension through the use of a video game in a military training environment, but the game is not specifically designed for the teaching or the practice of reading comprehension. In [54], a development and usability evaluation of a serious game intended to support and improve the reading comprehension skills of third graders (aged 8-9 years old) from Mexico is presented. However, it is a fledgling work at the level of usability analysis and does not focus on the evaluation and learning of competences and levels of reading comprehension. In [55] the

effectiveness of a computer-based instructional program (e-PELS) aimed at direct instruction in a series of reading comprehension strategies is examined. The findings support the efficacy of direct instruction in specific learning strategies in a computer-based environment. e-PELS ("Programa de Entrenamiento en Lectura Significativa" or "Program in Deep Reading Comprehension") is a multiple-strategy instruction program for reading comprehension. These authors concluded that the use of multimedia technology improves reading comprehension in students, whether boys or girls of high or low performance. In [56] the effectiveness of the use of technological tools to improve reading comprehension is also verified. In particular, this article presents a work related with the impact of two web-based applications (an interactive, multimedia literacy software program and a digital process portfolio) on early elementary students' reading comprehension. The analysis of covariance showed that the students who used both tools obtained significantly better results compared to the controls in written expression and reading measured by standardized tests. In this respect, the correlation between reading comprehension ability and exposure to reading items in video games has been analyzed by other authors, from a general perspective [57] or for specific games, such as Walking Dead [58] or Age of Empires II [59].

The validation to date of technological tools to support and enrich reading processes, so important at primary school level, shows that educational video games can be used to increase motivation and to make reading evaluation and comprehension easier. With this purpose, we chose to develop a graphic adventure game (called *Time Invaders*) where the narrative plays a main role, as it drives the reading process through a set of continuous and discontinuous texts in a multimedia format presented to the player in the form of interactive ludic challenges. The narrative in this kind of video game is the key in two senses; first, it constitutes the main mechanism to provide motivation and second, it helps to correctly interpret the ludic challenges and fulfil the serious goals. Therefore, the narrative will be complex and critical, and it is necessary to put into practice a systematic process for the structuring of the narrative such as the one proposed in this work.

4.2 The game Time Invaders

The game *Time Invaders* has been designed by the authors in collaboration with a team of teachers and professionals of language didactics following the eight steps of the proposal. This multidisciplinary team designed a set of ludic challenges that are useful to work and evaluate the five blocks of competences related to comprehension: literal (CL), inferential (CI), critical (CC), global (CG) and meta-comprehension (MC). Those challenges are integrated in a narrative that turns the avatar into a hero who has to travel to the past to collect a number of objects that aliens from Uranus have been trying to steal from some distinguished owners: Cleopatra, Julius Caesar, Marco Polo, and the Catholic Monarchs, among others. Following this approach, the educational adventure is structured in five chapters. The first chapter prepares the main character for his/her mission and takes places in his/her room, in the Alhambra (an important monument in the city of Granada in Spain), and in the aliens' space ship. The remaining chapters are devoted to the adventures of the main character in Egypt, Rome, Castile and the Far East (with the corresponding time-space jumps carried out with the help of the aliens).

During the process of designing the narrative for *Time Invaders*, a narrative script (document 1 generated in the proposed design process) and a story document (document 2 generated in the proposed design process) were created, expanding and detailing the plot summarized above. Both documents served as a basis for the generation of the story structure document (document 3 generated in the proposed design process). In that document, a set of graphs that establish temporal relationships among the different parts of the story was compiled. The graph with the higher level of abstraction splits the story of *Time Invaders* into five chapters. This level is then split into sub-levels that specify what happens in the plot of the game into each chapter. In this manner, each chapter is structured in sequences, each sequence in scenes, and so on (document 4 generated in the proposed design process). In order to show the application of the proposed process, some parts of the story are now explained in more detail.

4.2.1 Alhambra chapter

The first chapter of the video game starts with a sequence that takes place at the main character's home, where he/she is preparing for a trip to the Alhambra (monument in the city of Granada). In the second sequence, the main character is at the Alhambra, where a lion from the famous "Court of the Lions" makes some tests to confirm that he/she is "the chosen one" (the person with a mission to save the human race from the invading aliens). In the story

document it is explained how, through this sequence, some interrelated puzzles are solved, ending with the entrance of the main character through "the secret door" that gives access to the next sequence. This sequence takes place in the spaceship of the "Uranus", aliens aiming to clone our planet by stealing objects from our history. As an example, Figure 4 shows the story document for a specific scene in this chapter, scene 2.6.

Scene 2.6. Visit the door of justice *[E8-. Justicia]*
Description: When avatar visits this room, he discovers that there is a brick and a key that could be the one that he needs to enter in the passage.
Characters: Avatar.
Objects in the scene: key, brick
(On one of the walls of the Gate of Justice there is a brick that attracts attention because it is somewhat loose from the wall. Above the door, there is an engraving of a key and another of a hand.)
Dialogues:

- The Avatar takes the brick from the wall and stores it in his backpack.

(AVATAR)
Ugh ... it weighs much, much more than normal.

- The avatar looks at the key

(AVATAR)
An old key ... Is it the key I'm looking for? "It's too high, I can't take it.

Reference image:

Fig. 4 Extract of the story document belonging to scene 2.6 in the first chapter of the game

In order to describe each scene in the story, the following fields are used:

- Scene and scenario in which it takes place (in square brackets),
- Description,
- Characters that take part in the scene,
- Objects in the scene,
- Sequence of dialogs that the characters perform in the scene,
- Image of reference.

In a first iteration, it is recommended to design a lineal dialog only with the relevant information to be told in the scene. In the subsequent iterations, the dialog can become more complicated, and often a tree diagram is needed to describe possible dialog choices by the main character and answers by the other characters in the scene. Scene trees are useful to check if all the paths through which the dialogue can flow are adequate to achieve the reading skills assessed in the game.

Figure 5 shows the event graph that represents the second sequence. As can be seen in the figure, puzzles are based on the obtaining and use of objects (ellipses in the graph) by means of different actions or events (rectangles in the graph). The objects (sweatshirt, brick, rocket…) appear at the scenarios (Gate of Justice, Court of the Lions…) or are given by other characters of the game (guard, lion…), and are stored in a bag that represents the typical "inventory" of adventure games. The scenarios in which each action is carried out are also depicted in the diagram (dashed line boxes). Events that are not framed in any scenario can be carried out in any place, as most of them are actions performed over the inventory (e.g., putting the battery in the flashlight). Nevertheless, most events take place in a specific scenario (get the brick out of the wall, play marbles, open the door...).

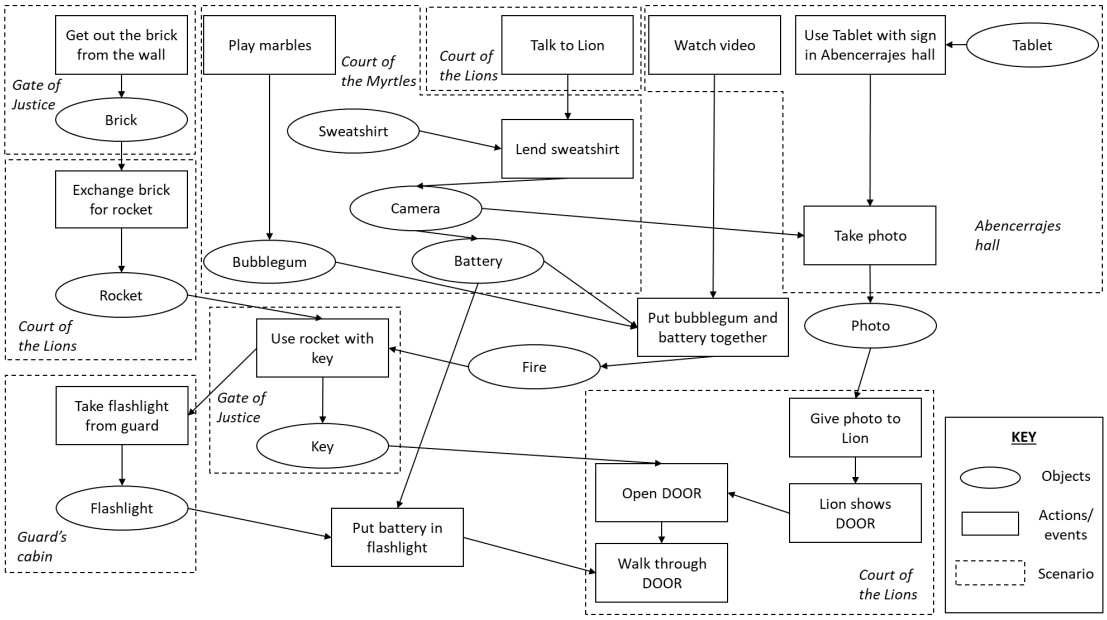

Fig. 5 Story structure diagram for sequence 1.2

The scenes-sequence diagram for the first chapter of the game is shown in Figure 6. It can be seen how this first chapter is divided in three sequences, labeled in the diagram S0, S1 and S2. S3 would cause the next chapter to begin. Specific sub-scenes are labeled 0.1, 0.2, 0.3, 1.1, and so on. The scenes take place in nine different scenarios (as can be seen in the diagram) and a cutscene (C1-BUS) that gives way to scene 2.1. Several scenes can happen in the same scenario, as is the case for scenes 2.1 and 2.10. In this case, the level of detail of the scenarios is high, including real images of the game, but this can be done with different levels of detail depending on the state of the design of the game. The diagram also shows the chronological order in which the story is generated as the scenarios are visited. This is represented with the links between scenarios. In the story document, it will be seen how each time sequence matches a specific scene in the story. Using a graph allows any inconsistent paths depending on the user's decisions to be identified and the flow of interaction to be modified.

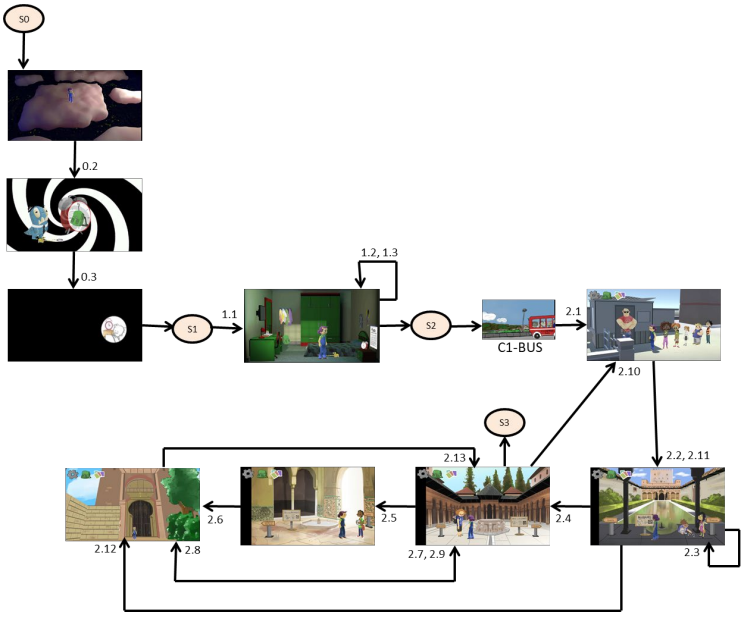

Fig. 6 Scenes-sequence diagram for the first chapter of the game

Fig. 7 Technical storyboard for scene 2.2 in the first chapter

During the development of the game, technical storyboards for validating the interactivity of the scenes and the feasibility of achieving the challenges were created. As an example, in Figure 7 we show the schematic drawing of scene 2.2 of this first chapter, which takes place inside the Alhambra. The interactive elements in this scenario are the two girls, a sign and two exits at both sides: to the Abencerrajes hall and to the Court of the Lions. The main character will have to get the bubblegum from Girl #1and the camera from Girl #2 to undertake a challenge set by a talking lion. Specifically, the challenge consists of taking a photo of the hall of the "cut heads". In order to achieve this, firstly, the main character would have to understand the explanation about the Abencerrajes hall (the hall of the "cut heads"). The explanation appears when the player touches the sign. The bubblegum will be used to light the fuse of a rocket, following a magic procedure seen in a video, in order to obtain the key that opens a mysterious door. The child cannot achieve these challenges if he or she does not read the information conveyed by the characters, scenarios and objects comprehensively. The reading skills displayed by the child are recorded in the child's user profile for the purpose of issuing an evaluation report. Evaluations are performed at different points in the narrative, and are made possible by the narrative structuring.

4.2.2 Silk road chapter

Another example is the penultimate chapter of the narrative in which the main character has to find the diary written by Marco Polo (The book of wonders) after his travels through the Silk Road. This act is divided into five sequences comprising nine scenes. The first sequence takes place in a boat that sails through the Persian Gulf and comprises two scenes: a) getting Marco Polo's father and uncle to take the main character with them to the Silk Road (scene 1.1) and b) getting supplies for the travel (scene 1.2).

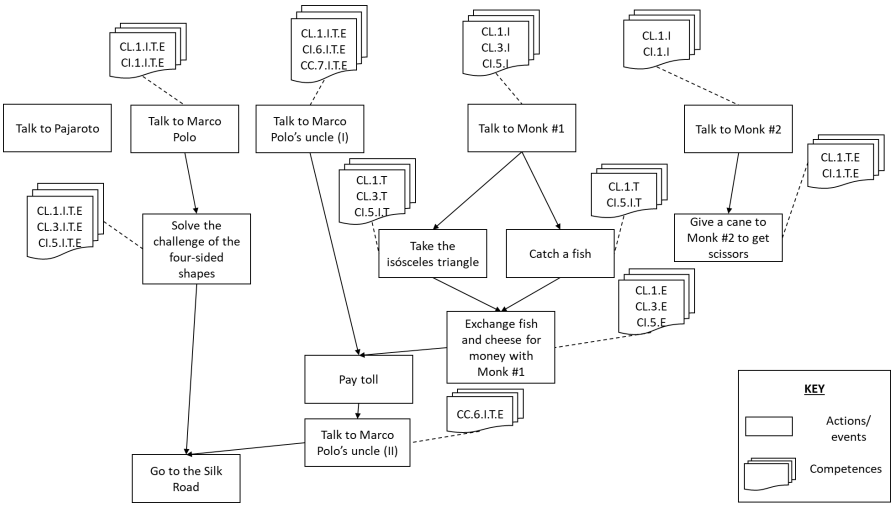

Fig. 8 Challenges/activities tree for scene 1.1 in chapter 4

Figure 8 partly depicts a challenges/activities tree relating to scene 1.1., where the relationships between educational competences and ludic challenges are specified. This mapping is done using the events in which the story has been structured in the scene, following the proposed narrative process. The competences have been labeled in the diagram following the approach of continuous evaluation of competences previously published by some of the authors in [60]. Educational competences have been identified in the diagram according to the list provided in the web site[3] of the video game. For example, «CL.1» is the first literal competence in this list and refers to the fact that the reader has identified a given piece of information within a text.

Fig. 9 Screenshot of scene 1.1 in chapter 4 (dialogs are in Spanish)

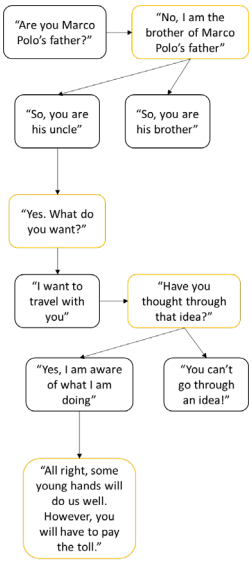

Fig. 10. Example of dialogs tree in chapter 4

Fig. 11 Example of cards used for depicting progress in the game

[3] http://bios.ugr.es/~nmedina

As already mentioned, in scene 1.1 (Figure 9) the main character has to convince Marco Polo's uncle to let him/her travel with him along the Silk Road. This scene takes place in a boat where they travel together with two monks, Marco Polo himself –who is not able to move due to the action of the alien invaders- and a bird from Uranus named Pajaroto, which accompanies the main character throughout the adventure. In this scene, the main character can decide to talk to Monk #1, Monk #2, Marco Polo's uncle, Marco Polo or Pajaroto, in any order. Each dialog implies the deployment of the given node in the dialogs tree, making up a dialogs subtree where the exchange of messages that starts with the chosen dialog can be visualized. The dialog will advance through one or other branch depending on the answer options that the player selects. For example, if the main character decides to "talk to Monk #1", he tells him/her that he is hungry and that he would eat some fish and an isosceles triangle of cheese (scene depicted in Figure 9), which initiates three competences: «CL.1.I» (identification of literal data), «CL.3.I» (option selection), and «CI.5.I» (deduction of information from images). These competences are worked («CL.1.T», «CL.3.T» and «CI.5.T») in an action "Take the isosceles triangle", where the player has to select the correct piece of cheese from the three on the table. The competences are then evaluated («CL.1.E», «CL.3.E» and «CI.5.E») once the cheese is given to the monk together with the fish. If the choice is correct, the monk will provide the main character with some coins as a reward. The coins will later be used as a toll payment for Marco Polo's uncle.

An example of a dialogs tree from chapter 4 is depicted in Figure 10. This is the tree for the conversation with Marco Polo's uncle previous to the trip to the Silk Road. The black boxes contain the main character's dialogs and the yellow ones Marco Polo's uncle's. As mentioned, during the game a score is given for each competence. This is later used for generating educational evaluation reports for parents and teachers. However, in order to provide progress information to children, a ludic system that uses a set of cards has been defined in the game [60]. This system allows children to see their progress in a synchronized way that is fully transparent and does not interrupt the playability of the game. A screenshot of this system of cards can be seen in Figure 11. In the figure, five cards can be seen. Each one is visible to a different degree depending on the players' progress. Progress is measured for each of the players' comprehension levels. To achieve complete visualization of a card, 80% of all the comprehension points of the scene must be satisfied.

5 Case study: Experience of use with the designed educational video game

The previous narrative process was carried out by members of the multidisciplinary research team, but also by members of the software development company Greyman Studios (responsible for game production), without any complications and with no significant delays in the planned times. Therefore, the case study allowed a preliminary validation of the proposal from the point of view of the process. To analyze the proposal in terms of the resulting narrative, an experience was conducted with 237 children (94 boys, 138 girls and 5 children who did not identify their gender; with an average age of 11.5 years) from three schools located in the province of Granada, Spain. The aim of the evaluation was to test the children's experience when playing the game, if the children enjoyed it and if they rated the game positively from different aspects including the narrative. Thus, the game was analyzed from the point of view of the players' satisfaction, specifically taking into account that the game has a high dependence on its narrative so that the game cannot be satisfactory if the narrative is not well designed. The sample, experimental protocol and results are described and discussed in the following sections.

5.1 Sample

The experience was conducted with a sample of 237 children from three schools: José Hurtado (JH), Santa María Micaela (SMM) and Caja Granada (CG). The sample was selected by the teachers in each school, according to pedagogical criteria and time availability. 148 of the children were enrolled in the penultimate course of primary education (fifth year of primary education in the Spanish educational system; 9 to 11 years old), whereas 89 of them were enrolled in the first year of Compulsory Secondary Education (first year of ESO in the Spanish educational system; 11 to 13 years old). All subjects enrolled in secondary education belonged to the CG School (that is, 38% of the total sample). The rest of the sample (students of primary education) was distributed as follows: 39 children from the JH School (16%), 39 children from the SMM School (16%), and 70 children from the CG School. Regarding gender, 40% of the sample were males and the 58% were females (it was not possible to

determine the sex of 2% of the children because they did provide this information in the post-questionnaire). Finally, the average age of the sample was 10.5 years in primary education and 12.5 years in secondary education.

5.2 Experimental protocol

One session was conducted for each group, except in the CG School where groups 5A and 5B participated in the same session. The experience was divided into a total of 9 sessions. Each session was composed of three parts: presentation, game playing and evaluation. The presentation part took five minutes to explain to the children that they were going to play a video game called "Time Invaders". They were then given a tablet with the video game already installed, ready to start playing. The game session lasted 40 minutes, during which the teams interacted freely with the game. Afterwards, the game units were collected and the students answered a questionnaire. The duration of this evaluation part did not exceed five minutes. The questionnaire, detailed in the following section, was a paper-and-pencil questionnaire occupying one page. All the questionnaires were anonymous.

5.3 Survey questionnaire

The survey questionnaire (table 1) was designed in order to cover the following aspects of the Time Invaders game: a) the difficulty of the game, both to learn to play (q1) and to play (q2), b) the appropriateness of the artistic part of the game, that is: story (q5), characters (q6) and multimedia (q3 and q4), c) the appropriateness of the technical part of the game, specifically the user interaction (q8), d) the appropriateness of the challenges (q7) and the trading cards system to display the score in the game (q9), e) the empathy with the protagonist (q11 and q12), f) the perceived learning (q13 and q14), and g) the weak aspects to improve (q15). Additionally, a question about the overall satisfaction of the game was included (q10). Complementary to this, each subject was asked about their age and sex, as well as their favorite video game (open question).

Table 1. Questions included in the questionnaire

nº	Question	Response options
q1	Indicate the degree to which it has been easy for you to learn to play:	Difficulty scale
q2	Indicate the degree to which it has been easy for you to play:	Difficulty scale
q3	Indicate in what degree you liked the artistic part of the game (graphics):	Satisfaction scale
q4	Indicate in what degree you liked the artistic part of the game (sounds):	Satisfaction scale
q5	Indicate in what degree you liked the story that is told in the game:	Satisfaction scale
q6	Indicate in what degree you liked the characters in the game:	Satisfaction scale
q7	Indicate in what degree you liked the challenges of the game:	Satisfaction scale
q8	Indicate in what degree you liked the way you interact with the game (to pick and use objects, to dialogue with characters, etc.):	Satisfaction scale
q9	Indicate in what degree you liked the way the game is scored (by means of trading cards):	Satisfaction scale
q10	In summary, indicate in what degree you liked the game:	Satisfaction scale
q11	Indicate in what degree you have understood how the protagonist feels:	Quantity scale
q12	Indicate in what degree you have felt identified with the actions of the protagonist:	Quantity scale
q13	Indicate in what degree you have noticed that you were learning:	Quantity scale
q14	What have you learned with the game?	Open question
q15	What aspects of the game do you think should be improved?	Open question

Table 2. Likert scales used in the questionnaire (values from 1 to 5)

Likert scale					
Difficulty	Very difficult	Difficult	Normal	Easy	Very easy
Satisfaction	I didn't like it	I liked it a little bit	I liked it	I liked it very much	I loved it
Quantity	Nothing	Little	Something	Quite	Much

To facilitate the understanding of the survey and minimize the effort of the respondents to complete the questionnaire, simple and concise wording was used and most of the questions required a closed-ended response. Specifically, three multi-item scales of the Likert type (table 2) were used to collect data from questions q1 to q13 (table 3). Each unipolar Likert scale permitted the respondent to indicate the degree of presence or absence of a quality: difficulty (q1 to q2), satisfaction (q3 to q10) and quantity (q11 to q13). In addition, two open-ended questions were included (q14 and q15), where respondents could provide a response in their own words to express what they had learned and what aspects should be improved in the game.

5.4 Results

Table 3 summarizes the descriptive measures of the results obtained in the survey for questions q1 to q13 of the questionnaire, including: a) measures of the central tendency, such as mean, median and mode; b) measures of variability, such as variance and standard deviation, and c) measures of the shape of the distribution, such as kurtosis and coefficient of asymmetry.

The distribution is very slightly "asymmetric to the left" in all the questions (except in q12 where most of the values are above the mean). In addition, the distribution is Platykurtic in all the questions except q1 and q2 for which the distribution is Leptokurtic. However, all the detected variations are very small. Furthermore, the internal consistency index measured as Cronbach's alpha coefficient is 0.882, indicating the reliability of the results and of the questionnaire.

Table 3. Descriptive statistics: q1 to q13

	Mean	Median	Mode	Variance	Deviation	Kurtosis	Asymmetry
q1	3.56	3	3	0.81	0.9	0.25	-0.19
q2	3.46	3	3	0.78	0.88	0.51	-0.14
q3	3.49	4	4	1.15	1.07	-0.54	-0.33
q4	3.25	3	3	1.2	1.1	-0.46	-0.21
q5	3.74	4	4	1.24	1.11	-0.27	-0.66
q6	3.26	3	3	1.22	1.1	-0.5	-0.31
q7	3.69	4	4	1.16	1.08	-0.33	-0.59
q8	3.37	3	3	1.06	1.03	-0.3	-0.28
q9	3.33	3	3	1.19	1.09	-0.48	-0.31
q10	3.81	4	4	1.1	1.05	-0.03	-0.66
q11	3.52	4	4	0.95	0.97	-0.13	-0.42
q12	2.97	3	3	1.49	1.22	-0.91	0.02
q13	3.39	4	4	1.41	1.19	-0.74	-0.37

In quantitative terms, the results obtained are positive, since all the means, medians and modes are between 3 and 4 (except the mean of question q12 which is 2.97). In addition, the most highly valued question is q10 (3.81), which demonstrates general satisfaction with the game. Finally, it should be noted that q5, about the story used for the game narrative, was the component of the game most highly valued on average (3.74). In fact, the questions

most directly related to the narrative are q5 (story) and q7 (challenges) which are given the highest valuations after general satisfaction, pointing to the success of the process of structuring the narrative outlined in the proposal.

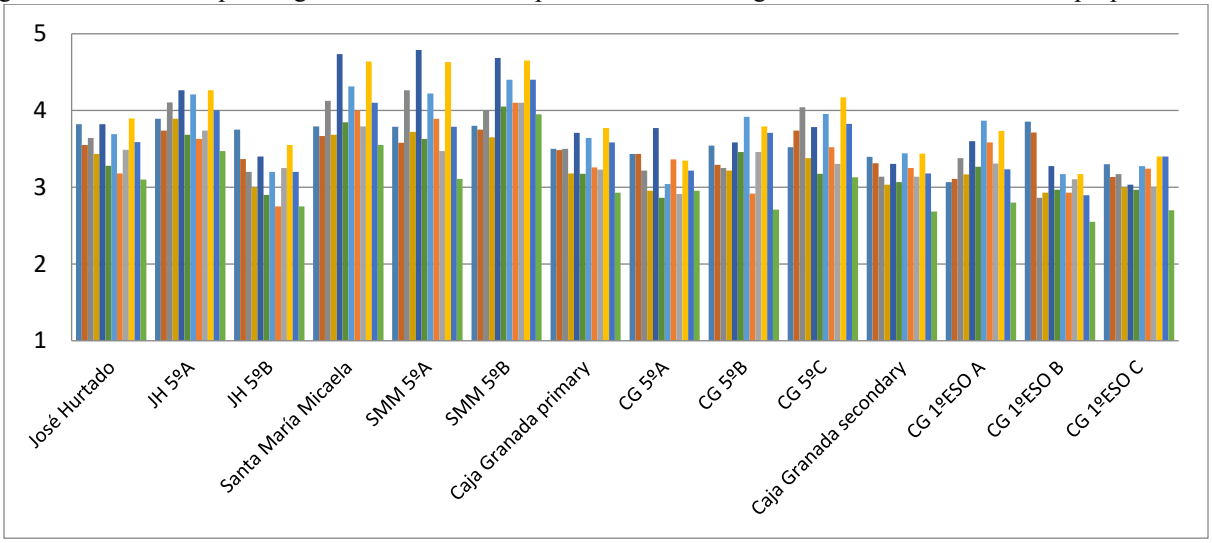

Fig. 12 Means by school and group (q1 to q12).

Figure 12 disaggregates the results of questions q1 to q12 for each school and group. As can be noted, the best results were obtained in the SMM school, which obtained a mean of 4.64 in q10 (general satisfaction about the game) followed by the JH school (3.9 in q10). At the other extreme, the worst results correspond to the CG school, especially from students in the secondary level, where a mean of 3.44 was obtained for q10. In any case, the results are positive in all the schools and groups since the means for all the questions are almost always between 3 and 4. Question q13 ("Indicate in what degree you have noticed that you were learning") has not been included in this analysis (Figure 12) because in an educational video game the ideal is that the players perceive learning (in this case, reading comprehension) in the lowest possible degree.

In order to detect whether students actually realized that they were practicing reading comprehension with the game, we conducted a new analysis summarized in Figure 13. This analysis was based on q13 and the open-ended question q14 ("What have you learned with the game?"). Each bar in the graph represents the results for a different group (14 groups in total). All bars are divided in partitions (a different color is associated to each partition). The total number of partitions is 8. If we take as a reference the fourth group (Caja Granada secundaria), the first partition of the bar represents the number of students who claimed to be learning something while using the game ("awareness of learning", q3 > 0). The next seven partitions reflect the number of students who indicated that they were learning (q14): "nothing/play" (second partition in each bar), "about the Alhambra" (third partition), "to have patience" (fourth partition), "to work in a group" (fifth partition), "explore/search" (sixth partition) and "to think and be attentive" (seventh partition) and "reading" (eight partition). Some groups do not include all partitions, because no student in that group gave the corresponding answer, but in all cases the first partition is "awareness of learning" and the last partition is "reading".

This comprehensive analysis (Figure 13) demonstrated that, although 87% expressed "awareness of learning", only 8.10% of children detected that they were working on "reading comprehension". For example, in the first group (CG 1º ESO C), 24 students indicated that they had perceived that they were learning something through play, but only 2 students identified that what they were working on was reading. This was similar for all groups. In conclusion, the students did not discover what they were learning through the game, which is desirable in order to maintain ludic motivation. This result suggests that the desired educational-ludic balance has been achieved.

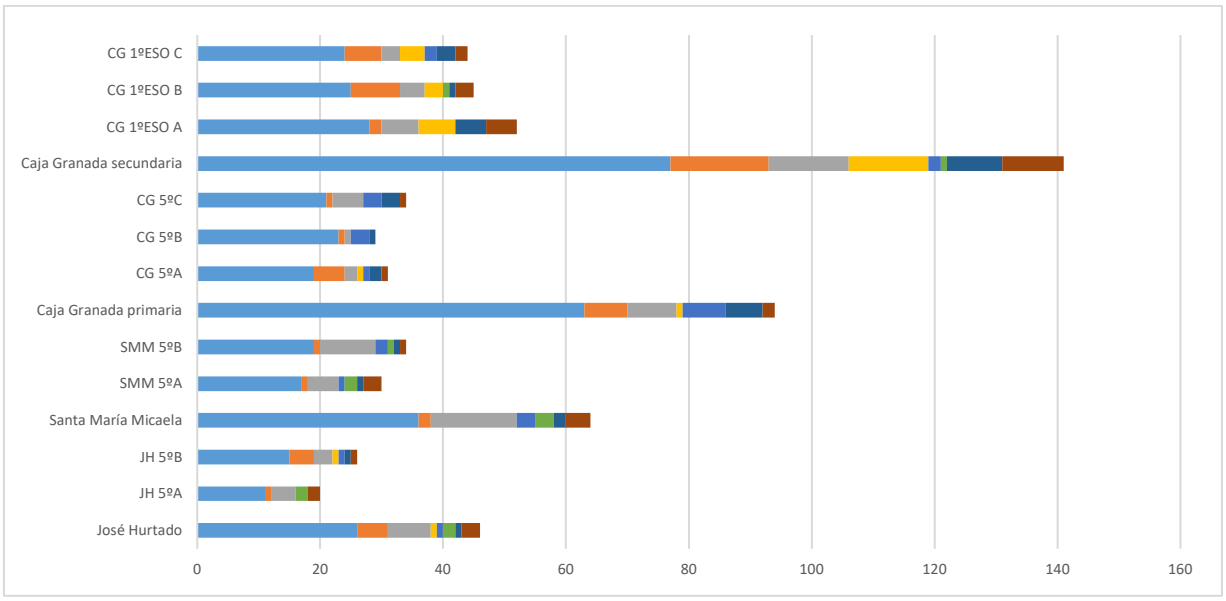

Fig. 13 Perception of learning by school and group.

Finally, a comprehensive analysis (Figure 14) of the open-ended question q15 ("What aspects of the game do you think should be improved?", allowing several answers for each child) allowed us to identify the weak aspects of the video according to the respondents. It seems significant that only 24.47% of the sample identified the need to improve some aspect of the video game (first partition in each bar in figure 14), the following being the improvements most frequently mentioned: interaction (9.28%, third partition in each bar), graphics (5.9%, fourth partition), sounds and music (2.95%, fifth partition), and challenges (2.95%, last partition). Additionally, a very positive result was that 8.43% wrote "nothing, it is perfect" (second partition in each bar) in response to the question of what should be enhanced in the game (q15).

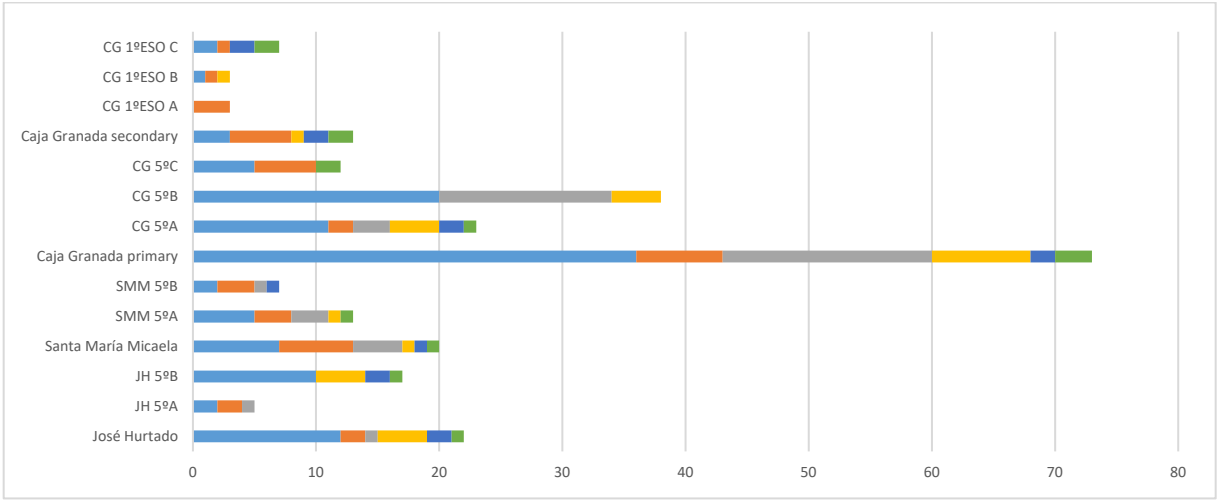

Fig. 14 Aspects to be improved by school and group.

6 Discussion

By employing the taxonomy presented in Figure 1 to classify the scientific approaches for designing educational video games, we can place the proposal made in this work at an intermediate level of abstraction in the y-axis (*abstraction level* in Figure 1). Specifically, the presented proposal is a "process for the narrative design of the game", which means that it focuses on organizing the creative process of the video game narrative, defining stages, documents and other methodological elements that allow the designer to carry out this process in a more conscious and structured way. This way of structuring the narrative process, together with the continuous generation of conceptual and technical design documents, aims to improve the quality of the resulting narrative as well as to facilitate the task of the narrative designers and the subsequent evolution of the narratives created. Since we move to an intermediate level of abstraction, the proposal starts from a conceptual framework and a set of design guidelines, but is compatible with multiple languages and software technologies, giving designers some freedom to use software tools of their choice to support their creative process.

Given that one of the main design principles for educational games is the balance between the ludic and the educational dimensions of the game, with respect to the *purpose* axis (x-axis on the left in Figure 1) the proposal is situated at the point farthest from the origin of the coordinates ("relation between serious and ludic parts"). This means that the narrative can be used to integrate the educational dimension within the ludic part of the game. Some considerations have been included in the proposal with this aim. Finally, regarding to the *focus* axis (x-axis on the right in Figure 1), the presented proposal is placed at the point denominated "multidisciplinary team", because the experts who have the knowledge about the serious purpose of the video game (teachers, educators, school counsellors and other educational experts in educational games) must be integrated in the process of generating the video game narrative as a requirement for learning to be effective.

A comparison of the proposal with other proposals that structure the game discourse, such as the GDA approach [42], shows that the top-down decomposition approach is a strong point of our proposal, since our process starts from a general vision of the plotline of the game which is structured into chapters, then in sequences and finally in scenes. This way, the narrative necessary to support the events in a scene is analyzed for each specific scene, instead of having to think from scratch what blocks of information are required to complete all tasks of the game, as in the case of GDA. Consequently, it can be said that in our proposal, information flows are easier to represent. However, some of the techniques proposed in GDA to analyze the information blocks could be integrated and be useful in our proposal, particularly the cognitive ergonomics analysis techniques [42]. What could not be addressed in GDA is the particularity of narrative in educational video games, since it is a general proposal. Similarly, another interesting proposal to simplify the creation of narrative in games is uAdventure [61]. This proposal is a framework built on top of Unity with the goal of simplifying the creation of narrative for "point and click" adventure games by non-experts. The model of uAdventure is based on narrative game elements such as scenes, interactive/non-interactive elements, characters, items and cutscenes. Therefore, its narrative structuring is compatible with the process proposed in this paper and its integration into the narrative creation process proposed may be advantageous.

In addition, a comparison of the proposal with other proposals that address the problem of defining narrative in educational games can reveal some interesting insights. For example, the visual language for the creation of narrative educational games described in [62] represents narrative as a state transition diagram that structures the story flow in a graphic format and integrates some educational aspects. This visual language was conceived to be used by educators themselves and it can be very useful in simple games, although it works only at the language level as a methodological approach is lacking, unlike our case. Another valuable approach is provided by the NCID process [43], which focuses on the cooperation between designers and informants to ensure that the game meets the knowledge needs of the learners. The work is interesting, but it primarily focuses on the collaboration with stakeholders to gather the key information for the story, rather than on the process for writing and structuring the narrative. In contrast, the proposal presented in the present paper covers the narrative process, the design documents, and the representation diagrams obtained as result in each phase of the process, together with the integration of educational elements in the game. Therefore, in our opinion, it represents a necessary contribution to the area, which lacks a proposal as complete as the one described in this paper for designing narrative in general games and educational games.

In order to validate the usefulness of the proposal, we decided to apply the process in the construction of an

educational video game called Time Invaders. This made it possible to verify that both the proposed process and the technical documents prepared during the process were understandable for the members of the development team and the educators, facilitating communication among them. Additionally, a validation experience was conducted with 237 school-age children. Its evaluation (detailed in the previous section) revealed satisfactory values when testing whether the children liked to play and, indirectly, whether they liked to learn through playing. In other words, we have tested the playability of the gaming taking as a basis the game experience. The positive scores given to the story and the challenges of the game (questions q5 and q7, directly related to the narrative), reinforced by the general positive game experience and reported playability, suggest the utility and suitability of the creation process for generating good digital narratives. Regarding issues to take into account for further versions of the game, some improvements were suggested, especially in the graphics and in the interaction (q15) and in achieving greater empathy with the characters (q12). The characters are also part of the narrative, so we will consider whether more emphasis should be given to the design and characterization of the characters in the proposal.

The evaluation carried out focused on a case study and players' satisfaction. We are aware that this constitutes an indirect measure of the game narrative. It is worth noting that the evaluation of the effectiveness of a narrative is not a trivial problem, which involves two unresolved issues on which we will continue working. The first issue is the analysis of the story itself; in our case this can be addressed due to the strong narrative structure and to the possibility of analyzing and labelling each element following the classic story structures such as that provided in [63] and the stages in the hero's journey. The second issue is the evaluation of the players' perception of the story they are living in the game. This aspect is more complex to evaluate due to the interactive nature of video games and to the changeable nature of the story. We are working on the idea of using narrative intensity as an evaluation element. This intensity evolves dynamically throughout the game as different elements (challenges, scenarios, plots or characters) become incorporated. We are also working on labelling the narrative intensity provided by each narrative evolution designed for the story.

Finally, it is important to establish that the proposed narrative design process is useful for video games where the narrative has considerable quantitative and qualitative importance in the user interaction. For this reason, it is clearly useful for educational games, but it could also be useful for other serious games and for all games in general (the purpose for which it has been designed). It would not be useful for games where there is no narrative, even if they are educational. The proposal is not aligned with any learning theory because, although it adapts very well to educational games, it is a general proposal. However, the process has been created to be flexible enough to accommodate different learning theories. For this same reason, the proposal does not include mechanisms to evaluate whether the narrative has served to improve learning outcomes (nor is this an objective of the proposal or of the experience conducted). In terms of educative effectiveness, the children who played the game scored higher on reading comprehension than the children who did not use the game (control group) in a parallel experience conducted with pre-test and post-tests. However, these data are not significant because the use of the game would have to have been prolonged for several months to be able to observe major changes in the children's reading skills, which is why they have not been included in this paper.

7 Conclusions and future work

Narrative in video games is an element that generates a direct impact on the player experience. Therefore, it is essential to design the video game narrative so that the story evolutions generate motivating gaming experiences. With this aim, in this paper we have proposed an iterative approach to design the narrative of video games, composed of a narrative structure, a narrative process and a set of design documents generated as a result. The process defines eight steps carried out iteratively as many times as required: 1) to define the main idea, 2) to explore and learn, 3) to define the storytelling, 4) to define the technical aspects, 5) to develop a playable prototype, 6) to integrate the multimedia elements in the story, 7) to share, proof and test, and 8) to get feedback and reflect. By following these steps, the story starts from a dramatic idea and progresses from a set of narrative evolutions to a complete narrative structure and finally to a set of story instances that can be lived by the players. All of this is designed in a set of seven documents developed throughout the proposed process which make up the definition of the game itself: narrative script, story document, story structure diagram, scenes-sequence diagram, technical

storyboard, dialog tree and object description document. Thus, the proposal makes narrative creation easier and more systematic and structured. It can be expected that a creator aiming to add narrative during the design stage of his/her video game would be able to generate a high quality narrative by using our process.

The suitability of the proposal was tested in the development of a narrative-rich educational video game, named *Time Invaders*. This game is aimed at developing reading comprehension abilities in children. The narrative process was followed by the researchers (who also acted as game designers), but also by experts in language teaching and by members of the software company that developed the game (Greyman Studios), correctly and on schedule. An evaluation with 237 children playing the game was then carried with positive results of player satisfaction, especially in those aspects related to the narrative: the story and the challenges. These positive results in the creation and use of a game where narrative is the key suggest that the proposed narrative creation process is easy to apply and useful for creating attractive games.

Future work will include applying the narrative creation process to other cases of educational video games and carrying out the pertinent evaluations to validate its utility in different contexts. Finally, comparisons will be made with developments that do and do not use the design process proposed for structuring the narrative, in order to measure the impact of our proposal on the development (time and cost) and the success (motivation and educational effectiveness) of the resulting game.

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Data Availability

The research data associated with this paper are included in this document and also available in hard copy at the University of Granada.

Declarations

The authors report there are no competing interests to declare.

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