Modeling storytelling to be used in educational video games

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ABSTRACT

Including storytelling in educational video games is currently a highly studied field as it is one element with which to maintain students' motivation. From previous studies, we have confirmed that including changes in the story changes the way in which students perceive the video game. In this paper, we present an extension of our previously defined VGSCL (a reference model for educational game development incorporating collaborative activities), in which balanced ludic and educative contents were designed. With this extension we focus on the storytelling itself, highlighting elements included in the story composition, attributes to be defined and relationships to be specified in order to integrate this proposal in the existing model. In addition, due to our target group being aged from 3 to 7, we have introduced some considerations to adapt the general rules to these children. Finally, we present the process followed to incorporate digital storytelling in the educational videogame "Ato's Adventure", the educational goal of which is to train grapho-motor skills.

1. Introduction

One of the most important factors in enabling students to learn through educational videogames is the maintenance of high levels of motivation throughout the game. For several years, the use of new technologies in classrooms and the introduction of video games into learning processes have been proposed as suitable mechanisms to achieve these levels of motivation. In order to further improve the results observed, elements which could have been omitted from these mechanisms are currently being studied. One of the main problems found in this sense is explained in (Padilla-Zea, 2011), which states that current video games, or at least those to which teachers have easy access, are not as fun as students expect. This causes educational video games (EVGs) to be more educational than video games. Moreover, one of the most important problems arises when the EVG design starts. It is a complex process which needs to integrate goals and tasks from two points of view: teaching a specific educational content and hiding it in a set of ludic goals to efficiently motivate students. Although specific methods and tools to develop video games exist, most of them are strongly oriented to the educational process (for example, SAVIE (Sauvé, 2009)) or to a specific type of video game (for example, EDoS, (Tran, George, and Marfisi-Schottman, 2010)).

Consequently, results obtained from using these video games could be improved.

In some cases, teachers have chosen to use commercial video games as part of their educational program, which ensures, to some extent, that motivation is maintained (a set of experiences can be seen in (Padilla-Zea, 2011)). The Manual for Teachers by Felicia (2009) explains how to make these sessions part of the lesson plan, so that the outcome of these sessions is satisfactory to both the students and the teacher. However, using commercially successful video games in the classroom requires a significant effort on the part of the teacher because they are not typically designed to fit within the content and time constraints of classrooms (Moreno-Ger, Burgos, Martínez-Ortiz, Sierra, & Fernández-Manjón, 2008) (Grove, Bourgonjon, and Van Looy, 2012).

To confront this problem, we have proposed a systematic method to designing EVGs that allows teachers to hide the educational content under the fun content (Padilla-Zea, 2011). This process requires, amongst other things, maintaining a balance between the educational and the fun content, in such a way that the EVG is neither a boring game for students nor an unproductive game for teachers. In addition, this proposal facilitates the assessment of learning achieved. Some guidelines to designing EVGs exist (Padilla-Zea, González-Sánchez, Gutiérrez, Cabrera, and Paderewski, 2009) (Ibrahim, Gutierrez, Paderewski, González, and Padilla-Zea, 2012) but they are focused on the elements that define the video game (mechanics, interaction...) rather than on the very important issue of introducing the storytelling into the design process. However, some authors suggest that the interaction processes and their integration into a good story can determine the success or failure of the game (Göbel, de Carvalho Rodrigues, Mehm, and Steinmetz, 2009).

In this article we highlight the importance of maintaining the balance between fun and education and, in particular, we focus

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on the introduction of the narrative as the basis of fostering the students' motivation in learning processes mediated by EVGs. To do so, we propose a set of models to be added to our methodology, including storytelling as a priority element in the modeling and development of an EVG. We start by integrating the specific models of educational and ludic aspects of an EVG in the story. These models specify elements to be defined and restrictions between them, as well as how to connect them with educational and ludic content previously defined by our methodology.

Including storytelling in a video game fosters and maintains the motivation students feel when they are using that video game as an educational tool. There are several proposals which, with nuances, refer to motivation in EVGs. Thus, (Law & Kickmeier-Rust, 2008) cites the strengths of EVG according to (Prensky, 2001): high level of intrinsic motivation to play and advance in the game, clear rules and objectives, a rich and attractive learning environment, a story with elements to foster immersion and surprise, instant feedback, a high level of interactivity, challenges and competition. These features are supported by the successful model of learning by (Merril, 2002): (1) focused on the problem: the student is involved in solving real-world problems, (2) activation: learning is promoted when activating prior knowledge, (3) demonstration: learning is promoted when what is going to be learnt is proved rather than when it is said, (4) application: students use their new knowledge to solve problems; (5) integration: students apply what they have learned in their daily lives.

The rest of the paper is organized as follows: In Section 2, research related to the inclusion of digital storytelling in EVGs is commented on; in Section 3 we present a brief analysis of some educational games for mobile devices that currently exist, to explain, in Section 4, the lessons learned about narrative and the state of current EVGs. In Section 5, the proposed extension to design storytelling for EVGs is presented and, in Section 6, the design performed for the EVG "Ato's Adventure" is shown. Finally, in Section 7, our conclusions and future work are outlined.

2. Digital storytelling as a motivational element

The scientific community recognizes that activities in a video game need to be inserted into a game story to get a proper degree of immersion. We think that this statement is also applicable to EVGs since immersion encourages motivation and, therefore, learning.

However, digital storytelling can also be utilized as a reward, revealing certain parts or details of the story as the player overcomes the game's challenges (Bopp, 2008). In both cases, a good story supports what is known as a parasocial phenomenon, related to the feelings generated in the player about game characters: the feeling that the player has to protect the protagonist and thwart enemies. These parasocial feelings have a motivational function to encourage the educational process contained within the game.

Therefore, the game's story and actions developed within it should encourage these behaviors (Bopp, 2008). To do this, video games must: (1) define a goal in the game, (2) divide the main goal into sub-goals, (3) ensure that the player can relate the actions taken in the game to any of these sub-goals and to the video game's final goal, and (4) ensure that the player finds tasks which provide him/her with experiences of success and reward in order to maintain motivation.

Various researchers have studied the importance of introducing digital storytelling into EVGs as a key element in maintaining motivation. In (Law, 2008) it is proposed that the story be adaptable in order to customize the personal experience as well as to adapt this story to each player's goals, needs, abilities and preferences. In particular, the terminology used in e-learning is adapted to the EVG.

Thus, the term Macro-adaptation is proposed for traditional adaptive techniques (presentation and navigation), against the term Micro-adaptation, which is related to actions occurring within learning situations, not around them.

Other authors (Göbel et al., 2009) include digital storytelling as an essential part of EVGs, considering three fundamental elements: learning, play and story. These aspects are complementary and a balance must be found between them in order to improve motivation. These authors have proposed a scheme which achieves this balance and it has been used in the first demonstration of the 80 days project.[1] This scheme consists of an introduction, in a cinematic style, to introduce the story; an interactive tutorial to introduce the theme of the game; and a set of missions which make up the game's levels. Related to this approach is that proposed in (Bopp, 2008), which uses a system similar to that developed in Hollywood movies. Thus, the story is presented as a series of events that occur around a protagonist, the hero, who can be a single character or a set of them. This hero tries to overcome all obstacles to achieve a final goal. Furthermore, they propose to include videos as an introduction to the game or in the transitions between levels.

Moreover, other studies have suggested a new term of motivation to refer to that which occurs when playing an EVG which incorporates proper storytelling (Bopp, 2008). Traditionally, we have distinguished intrinsic (caused by the action being performed) and extrinsic motivation (on the consequences of such action in the real world). However, the authors in (Bopp, 2008) propose the term virtual extrinsic motivation: In an EVG, extrinsic motivation comes from consequences that acts have in the virtual world.

Within EVGs, we find a special sub-type called serious games (Michael & Chen, 2006). In these games, the motivating element has traditionally focused on simulation, ignoring the inclusion of a story that supports the activities undertaken. Currently, in the state of the art of video games, motivation is not only bound to the desire to win against the computer or in a competition, but to take part in the story of the protagonist (Bopp, 2008). Therefore, the motivation of players, i.e., of students, would improve if elements of storytelling were included in such a way that parasocial feelings could easily emerge, as far as possible, both for boys and for girls.

Admitting that the introduction of digital storytelling encourages a sense of fun, other authors have proposed specific mechanisms to introduce storytelling into EVGs (Champagnat et al., 2010). In this regard, two groups have been identified:

(1) The emergent narrative, where the player is free to do whatever he/she wants and the quality of the game depends on the player's skills and the actions taken during the game.
(2) Story-based games, where the player cannot influence the course of the game. In this work, the authors propose the use of interactive digital storytelling as a tool to promote freedom in the game and allow the player's actions to control their own story.

Specifically, this latter proposal is based on the design of emerging stories ((Cavazza et al., 2002; Lugri & Cavazza, 2006), for example), wherein the game contains a rich and complex world in which the characters can evolve freely and autonomously. Thus, the authors believe that a story is a partially ordered set of events that occur around a character, an object or a topic. In this way, the story begins from a starting point to solve some problems that lead to the final state, which is an acceptable conclusion to the problem.

Considering these previous works, we propose an EVG modeling method based on a structure learning-play-story, where we establish a relation between elements at each of these levels. This model

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[1] http://www.eightydays.eu/

allows for the representation of both games, those in whose story the player has no bearing, and games whose narration adapts to each player's goals, needs, abilities and preferences. To give EVGs this capability, we represent the story as a set of interrelated narrative elements. These connections are defined in such a way that we are able to define conditions in order to ensure the proper development of an adaptive story.

Finally, other researchers are working on adapting storytelling according to players' emotions. Specifically, in (Merabti et al., 2008) we find a proposal in which characters in the game change their feelings and behavior according to actions performed by the player.

We are currently working on the analysis of emotions that players feel when they are playing an EVG and our work to be undertaken in the immediate future is related to modeling games in which the storytelling can change dramatically depending on the player's actions and emotions. Later in this document, we will explain how we have modeled the narrative units (which we call scenes) in a story and how they are related to withstanding changes in the order in which they are narrated without creating inconsistencies within the story.

3. Analyzing educational video games

As a starting point of our work, we performed an analysis of existing EVGs in one of the most important markets of mobile applications (Apple's App Store) for the age range we were interested in, between 3 and 7 years. The objective of that study was to analyze the needs of these systems, the problems that exist and their direct or indirect relationship with the existence of storytelling in the video game.

In previous works, we developed a method to evaluate emotions based on the observation and analysis of children's behavior while they were using educational applications (Padilla-Zea, González-Sánchez, Gutiérrez, Abad-Arranz, and López-Arcos, 2012). The analysis performed showed how the children's interest in the proposed games decreased faster than desired when the application did not provide a strong ludic component. Given the growing popularity that mobile touch devices currently have, it was decided to focus the study on existing applications for this kind of device. The study began by analyzing how and to what extent the available applications integrate the entertaining and educational parts.

In the following paragraphs, a set of the applications studied is detailed. Given the great success of these applications, we can find a specific category in the App Store, grouped as follows: stories, fun, games, letters and words, numbers and math, games for learning and abilities. This study is structured according to this categorization, selecting the games we have considered most representative.

3.1. Tales

This category is especially interesting for the purposes of this work, as it allows us to consider how to include storylines in games. Although there are numerous examples, here we discuss some of them whose features are relevant to our study. Thus, "Peppa Pigs me books" is a narrative (written and spoken) accompanied by illustrations that occur as pages of a story and allow some interaction with the player, such as recording his/hervoice. However, we think the main weaknesses of this application are its classic format and the difficult working of these tools, which limit the playability of this application. Meanwhile, "Alice in Wonderland" does present opportunities for interaction but away from the context of the story. Finally, with a stronger ludic nature, we can find the collection "itbook". However, the interactive possibil-

ities presented in all these games are limited and do not significantly affect the development of the story.

By contrast, we find "Goodnight Safari", one of the few applications in this category that allows the user to cause (simple) changes in the scene that lead to the next point of the storyline.

Perhaps one of the funniest applications, because of the freedom provided to the child to create stories and characters, is "Toontastic". This game is a tool to create cartoons easily. As it is presented, it is not intended to provide a storytelling narrative throughout the entire game; rather it enables the child to create the story, improving his creativity. In our opinion, it would be interesting to slightly reduce the player's freedom by providing one or more stories through which the players could develop their own ideas.

From this study, we see that including a story in video games is important, but it has to be integrated with the mechanics of the game, such as interaction, challenges, levels and scores. In general, the more mechanics are included, the higher level of playability the game will have.

3.2. Pure fun

Most of these kinds of applications which are oriented to children between 3 and 7 years of age, are based on painting and coloring. In "Preschool Connect the Dots", the player draws lines to connect a series of dots to form a picture, so there is an ultimate goal and an exercise is done while the user is playing. On the other hand, "Crayon Kid's Drawing for iPad", "Doodoo Pad" or "Color Play" are examples of applications in which the child can explore the painting tools to color different scenes. These games could be considered effective in learning or practicing specific skills.

One of these applications' problems is their repetitive nature, which can lead to loss of interest in the player. We believe that this is due to the absence of a storyline that keeps the focus on the end goal and the satisfaction of achieving short-term goals. This also occurs when technology is used as a motivational tool: a new device increases children's motivation but, after a short while, this motivation decreases if there are no other elements to maintain it.

On the other hand, we can integrate a learning process within a well-defined game technique such as a puzzle or a Sudoku, where the rules, the objective and the processes to solve the problems are well defined.

An example of this process may be the game "Awesum" that combines game techniques from Tetris and Sudoku to teach and practice addition.

In this case, the story proposed to the player is not so important because it is providing full and well-defined game mechanics involving the educational process within a fun process.

3.3. Games

In this section, we discuss some applications that are not specifically aimed at children. However, we consider them to be of great value to this study and they reinforce the importance of storytelling and art in the development of a successful application.

First of all, we analyze three games considered to be casual games because they allow the user a quick and simple form of fun in a short period of time. Still, all of them have a simple storyline that gives cohesion and meaning to the game.

The game "Angry Birds" is widely popular among users of touch devices. The game itself does not start from an original concept, even with the latest changes in the version "Angry Birds Space", since the catapult system has been used in video games since their inception. The main reason for the success of this game is that it maintains a continuous degree of difficulty in its challenges. In that way, the player can overcome the challenges after several attempts

without frustration, causing them a feeling of personal satisfaction (an important aspect of motivation). However, the effort put into graphic development, animation and sound and artistic effects, which enrich the game as a whole, making it look nicer, has also been very important.

"Cut the Rope" is a further example of a very successful application. In this game, the player's goal is to get a sweet to a cute character through gestures that cut the ropes from which the sweet is hanging. The animation and sounds are fun. Moreover, this game is based on a study that claims that feeding a child and, more specifically, the act of chewing, awakens a special feeling of tenderness.

On the other hand, there is another category of games that are more geared towards players who spend more time playing in order to complete long video games full of stories. These kinds of players are known as hard gamers. Here, the storyline is more complex and important. An example of this type of game is "Lego Harry Potter", divided into two fun action games that also tell the story of the famous series of books and movies.

3.4. Specific Educational Content

They are more educational tools rather than educational games, highly focused on teaching a specific subject but which include some elements from games, such as scores, characters and levels.

For example, there are several applications focused on *Language*. In this group we find some applications to write letters or words by using strokes, for example "Baby Writer", "World of Alphabet" or "Alphabet Connect". It is noteworthy that these applications, although intended to be indicative and to divide the exercise into small steps, do not evaluate its correctness. Moreover, there are others based on relating a letter or word to pictures of its meaning, such as "BabyWord_Food" or "Wild Alphabet", for example. Nevertheless, the problem is the same again: the lack of a story line causes loss of interest. Similar problems can be found in the category Numbers and Math, from which we highlight the applications "Motion Math: Hungry Fish" and "Robo Math".

Another example, framed in the History subject, is "Ansel and Claire's Ride with Paul Revere", in which Ansel and Claire are childlike aliens who want to learn about history. This application is focused on telling the player about events of American History rather than providing interaction or fun activities.

As we can see, many of these EVGs are more applications than games, which quickly cause boredom in children. We agree with studies which claim for educational benefits from video games, for example, recommendations made in (Felicia, 2009). Thus, educational game designers have to drive their designs to features of commercial games in order to maintain motivation but making easier the teachers' work. This means that teachers can easily identify educational contents in the game while students' attention is focused on the video game itself.

3.5. Skills

Games whose educational purpose is not to acquire certain skills but to promote or encourage any kind of skill in the player (creativity, imagination, art, memory, etc.).

For example, "Faces iMake" is designed to foster the imagination and creativity of children, allowing them to create faces with any kind of object, such as candy, toys or fruit.

We also found apps which foster skills from the educational process such as the graphomotor, reading comprehension, mathematical knowledge or 3D vision.

Examples of these applications are "The Letter School", which is designed to teach the script associated with each of the letters of the alphabet or, for children, "Smart Baby Games", which has a comprehensive set of tests to recognize shapes, colors and sounds.

These tend to be very focused applications proposing very specific goals and objectives that are not supported by any kind of story. They use fun and motivating techniques (child-friendly characters, sounds of approval, etc.) but in many cases they do not keep the player amused during long learning processes.

4. Lessons learned: the particular case of 3-to-7-old Children

In Sections 2 and 3, we have performed a brief study of the current proposals regarding EVGs for children, both from the academic (what the scientific community says) and the commercial (App Store) standpoint.

Regarding the introduction of digital storytelling in EVGs, although we agree with the proposals made by the authors cited, we think that some issues should be omitted when it comes to games for young children. Based on the importance of providing a storyline, we clarify some questions:

- Using cinematographic language seems to us to be a very interesting proposal for the range of 3–7 years old. This option allows us to give enough information to children in an entertaining and easy way. In addition, this language allows children to be placed in the story without them having to explore what to do before knowing why.
- Good characters should be designed in such a way that children can easily identify with them. On the other hand, villains have to be easily distinguishable from the former without causing feelings of rejection or fear.
- The final goal of the story should be simple, unique and presented clearly at the beginning of the game.
- The sub-objectives of the story should not confuse the student regarding their ultimate goal. Activities should be presented simply and clearly, maintaining the relationship between the activity and the objective of the game.
- While interactive and adaptive narratives seem to us to be interesting proposals, we believe that they could confuse players in the age range we are using. For this reason, we propose the use of a story-based storytelling. We also think that the possibility of storytelling providing rewards of sub-goals should be used cautiously at this level.
- Adapting the learning process is a potentially advantageous aspect of EVGs. Thus, we can use the story underpinning the video game to synchronize adaptive activity with alternative or optional scenes in a controlled way.

Regarding the implementation currently being carried out in most EVGs, we found some shortcomings. In our opinion, an important drawback of the reviewed games is that the fun component is not taken into account or not done properly. This causes a loss of part of the motivation associated with the fact of playing and, therefore, with the educational content to be taught or trained via that game.

Moreover, taking into account that children in early childhood education are able to perform a large number of different exercises, there is a notable lack of a variety (not so much of quantity) of educational games for children. Especially, as in our case, in games aimed at a target audience between three and five years old.

Finally, we believe that an educational application should be adaptable to the needs of each student. This feature was not found in any of the analyzed educational applications.

From the considerations made in this section, and based on the philosophy of "learning by play", we think that, in general, an EVG should:

- Incorporate a system to customize and adapt its working to certain user features, including a configuration system as versatile as possible.

– Provide a variety of exercises of progressive difficulty and avoid, insofar as it is possible, monotony. In addition, an EVG should evaluate the performance of each exercise.
– Integrate the educational elements naturally in the storyline, including multidisciplinary elements, and not limit them to a single subject.
– Present its objectives to users in such a way that they arise from the story of the game.
– Include different nice and bright images, objects, characters…, which react when touched, to foster investigation and to provide short breaks from the main exercise. In general, the application should be as interactive as possible.

5. Process to integrate storytelling into educational video game design

In previous works (Padilla-Zea, 2011), we have proposed an educational video games' design process, which allows the ludic and educational content of the same to be related to one another in a balanced way. In essence, this design process structures the educational content in a network of interconnected objectives and tasks, in such a way that a relationship between a task and an objective indicates that the task contributes to overcoming that objective. Between the game phases and levels there is a parallel relationship to the previously explained. Finally, a relationship between educational activities and activities proposed in the game is established. In this way, overcoming an activity in the game implies, indirectly, having trained or learned the educational content associated with it.

This process has been designed to involve teachers and game designers in the development of the EVG. In addition, it is intended to ensure playability requirements are included as objectives for the video game itself and are specifically related to educational goals.

5.1. Designing and relating educational and ludic contents for EVGs

As presented in (Padilla-Zea, Medina, Gutiérrez, and Paderewski, 2011), our proposal for the design of EVGs is a model-based approach which allows adaptations and personalization during the playing / learning process. We propose three sets of models: (1) models to define and monitor educational content; (2) models to specify and monitor ludic content; (3) models to relate the educational and ludic content, which show how the ludic content supports the educational requirements.

We define a set of dictionaries to organize those models. There is one dictionary for every group of models: the *Educational General Dictionary* (EGD) and the *Video Game General Dictionary* (VGD).

In the EGD we store models with information about educational contents to be used via our educational video games. These models are: Area of Knowledge, Educational Goal, Educational Task and Educational Model. An Educational Goal represents an item to be learnt, which is achieved by performing a set of Educational Tasks. Both Educational Goals and Educational Tasks can be divided into simpler Sub-goals and Sub-tasks, respectively. In that case, the Sub-goals in the lowest level will be related to Educational Tasks, while the others will only represent relationships between them. On the other hand, an Educational Model is a sub-set of the Educational Goals and Educational Tasks from the EGD. This model allows teachers to select what contents are going to be taught at each moment. In addition, as Educational Goals and Tasks have a set of features, the teacher can select only the most suitable Goals and Tasks for a particular session or according to the particular set of students. Finally, the Area of Knowledge Model allows contents to be organized by the Area of Knowledge to which it belongs. Both Educational Goals and Tasks are mandatorily related to an Area of Knowledge, but they can also include one or more Additional Areas of Knowledge.

In the VGD, information about a set of video games is stored. Similarly to the educational contents, ludic information is organized by using a set of models. These models are: Game, Video Game Challenge, Video Game Stage and Level. Similarly to the previously shown models for Educational Models, Challenges are achieved by solving a set of Stages and Levels. Both Challenges and Stages and Levels can be split into simpler elements. The Game Model defines the features of the game itself, such as target age, difficulty or type, for example.

Finally, we have the General Goals and Tasks Models, which allow us to establish the relationship between leaf nodes at Educational and Ludic levels. Relating a task at Educational Level to a task at Ludic Level means that the activity in the game contributes to learning or training the Educational Content included in the activity at the Educational level. In addition, Ludic Tasks without relationships can be included in order to maintain players' motivation and immersion.

5.2. Enhancing the system: the story general dictionary to model the storytelling

As explained in previous sections, our design process' goal is to make the development of EVG easier, both to teachers and to video games design teams. That means the video games we intend to develop include balanced educational and ludic contents and promote a motivating learning process. Although the design process works as expected, we think it is necessary to delve into the Game Model (Padilla-Zea et al., 2011). Thus, in this section we present an extension of our developing process focused on specifying the storytelling as an essential part of the EVG. Designing the story as structured elements allows us to relate each of these elements to the previously specified ludic activities and consequently to the educational content. Thus, we have included some new models to be added to the design process, as well as new relationships between these and previous models.

We propose to divide the storytelling into basic elements, which we have called *Scenes*. A Scene is a concrete event which is developed in a single place or *Scenario* and in which some specific characters appear. As seen in Fig. 1, a Scene can be: (1) basic scene if it shows a part of the story where an activity from the VGD is developed; (2) recreational activity if it presents a ludic activity that does not belong to the video game itself (VGD) but is an interactive break for the player; and (3) narrative cinematic if there is no interaction with the player but only the narration of something related to the story.

Scenes are grouped as *Sequences*. A Sequence is a series of related Scenes that causes a narrative evolution, which constitutes a distinguishable component in the story. Scenes in a Sequence are developed in Scenarios belonging to the same Zone.

Sequences are grouped as *Chapters*. A Chapter is a series of Sequences that have a meaning in the storytelling. In the case of an EVG story we cannot forget that its main goal is to maintain the attention and motivation of the player by including ludic elements, such as challenges, tasks, and puzzles. For example, we could say that a Chapter, as a specific part in the storytelling, has to lead to achieving a ludic goal or sub-goal. The Sequences in a Chapter are developed in Zones belonging to the same *Region* (See Fig. 1).

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. Let us imagine a Scene in which characters are fishing in the North Pole. We could introduce a fishing Scene in many other landscapes, but the situation would be strange if we chose a fishing Scene from a European river. Thus, we would have to choose a fish-
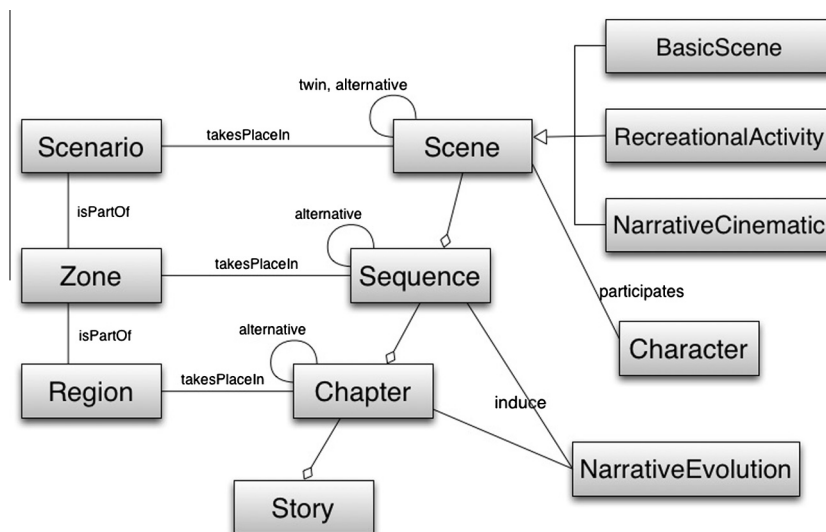
Fig. 1. Storytelling conceptual model.

ing Scene where the Scenario belonged to the *Zone* in which the North Pole was included. The same behavior is expected between Zones and *Regions*.

In order to organize components in the storytelling, our model includes a new Dictionary, similar to those that organize the Educational and Ludic Contents. Thus, the *Story General Dictionary* (SGD), besides having an entry for each of the previously described elements, 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. Specifically, the elements stored are Scenarios, Zones, *Regions* and Characters. All these elements are going to be referenced in the story recreated in the EVG.

Next, we present attributes for every model as well as a brief description of their meaning.

In Table 1, attributes for a Scene are described, as well as the domain from which they take their values. Here, we explain the most relevant ones, beginning with the case of *Twin Scenes*. As previously stated, an Educational Task may not have been learnt or trained as expected and the student would have to do the same activity again. Since EVG are supposed to include some kind of monitoring, in each of these monitoring points, the video game could determine if the student has successfully completed the task.

This situation could lead to the same activity being repeated if it needs to be reinforced. In this case, presenting the same activity with no reason from the storytelling standpoint could cause the player to lose interest because of a loss of immersion. To avoid this situation, this attribute identifies a set of Scenes that, developed according to the educational restrictions, are part of the storytelling development. For example, let us imagine a video game to practice graph-motors in which there is a Scene in which drawing ascending vertical lines is trained, as could occur in a fishing Scene (see the example in Section 6). At a particular point in the game, the player goes fishing because he is going to invite his friends to dinner at his house. If drawing ascending vertical lines needs to be repeated, we could present the same previous Scene if we previously introduce a video in which the basket containing the fish has been dropped by the character while he was going back home. And we could repeat it again if, once at home, his neighbor's cat eats the fish or if the player finds a post-it note telling him that more friends are coming to have dinner that night. Those situations allow the story to return to the same point and we have called them Twin Scenes which, from an Educational standpoint, allow us to adapt the learning process according to the student.

The attributes *Previous Scenes*, *Previous Sequences* and *Previous Chapters* allow us to establish order restrictions between Scenes,

Table 1
Scene model.

Attribute	Description	Domain
Identifier	Internal identifier	x: $x \in$ [SC00000, SC99999]
General name	General name that describes the scene and works as a dictionary key	x: x is a General name
Narrative evolution	Description of what happens in the scene	Natural language
Scenario	Scenario where the scene takes place	x: x is a Scenario
Characters	Set of characters which necessarily appear in the scene	$\{x\}$: x is a Character
Twin scenes	Set of scenes which are joined to the same ludic activity but include story variations so the player does not repeat the activity several times without a connection to the story	$\{x\}$: x is a Scene
Previous scenes	Set of scenes which must happen before this scene	$\{x\}$: x is a Scene
Previous sequences	Set of sequences which must happen before this scene	$\{x\}$: x is a Sequence
Previous chapters	Set of chapters which must happen before this scene	$\{x\}$: x is a Chapter
Required	This indicates whether the scene must happen to give meaning to the story	x: $x \in$ {Yes, No}
Alternative cinematic narration	If the scene is obligatory but its educational activity is not selected for playing, it points to a video that narrates the part of the story that the scene tells.	x: x is a reference to a video
Alternative ludic activity	If the scene is obligatory but its educational activity is not selected for playing, it indicates a ludic activity (without educational contents) that replaces the educational activity in the scene	$\{x\}$: $x \in$ Phases and levels of the game

Sequences and Chapters, respectively. Although some Scenes in a story could occur at different moments, enabling the possibility of specifying a narrative order is necessary. That order restriction is established by the attributes Previous Scenes, Sequences and Chapters. Moreover, we need to specify two kinds of order restrictions, because there are moments in the story when a change occurs and some scenes no longer make sense but would have if they had occurred before that time. However, there are some events that must occur to enable others. Thus, order relationships in our system can be *hard* or *soft*:

– Hard order restriction: A is hard related to B (A ➜ B) if A has necessarily to occur before B.
– Soft order restriction: A is softly related to B (A → B) if, in the case that both A and B occur, then A has to occur before.

It may be the case that there is no order restriction between two particular Sequences but there is between Scenes belonging to those Sequences. This may also occur with Chapters. This occurs because Scenes in an interactive story could overlap, in spite of their belonging to different Sequences or Chapters.

An empty value in the attributes' Previous Scenes, Sequences and Chapters indicates no order restriction with other Scenes, Sequences or Chapters.

Finally, we explain attributes related to mandatory attributes. The attribute *Required* indicates a Scene that has necessarily to be in the video game in order to maintain the storyline. For example, let us imagine an Educational Content that is not included in a specific instance of the EVG. This would be a problem if, for example, this content corresponds to the initial Scene in which evil characters steal an object that the player has to find during the game. That is the main goal in the game and it cannot be omitted.

However, in our model, the teacher can select the contents to be taught by the EVG. Thus, if the Educational Content to which some Scenes are related is omitted, those Scenes would not appear. But the narrative evolution of that Scene is completely necessary for the story to make sense.

To solve this contradiction, we have included the attributes *Alternative Cinematic Narration* and *Alternative Ludic Activity*. The first specifies a cinematic interval to replace the content in the Scene which has not been included, in such a way that the information is shown as a video. The second attribute, by contrast, does not replace the Scene, but the Educational Content included in it. This allows the inclusion of different Educational Content associated with the same narrative content. This alternative content could be both ludic and educational, which requires a greater effort from the designer as it implies the development of a Scene which works with different activities.

The more interactive the video game is the more immersive and fun it is. Thus, our recommendation is not to include too many cinematic sequences.

As previously commented, Scenes are grouped into Sequences. The Sequence Model is described in Table 2.

Similarly to the Scene Model, a Sequence only has an Identifier and a Name, as well as a description of the narrative evolution occurring in the Sequence. In addition, a *Set of Scenes* forming the Sequence is included. Scenarios in which Scenes in the Sequence are developed belong to the same *Zone*. The other attributes, similarly to the explanation in the previous model, determine the Sequences and Chapter occurring before this Sequence as well as whether the Sequence is Mandatory or not. If it is, the Alternative Cinematic interval or Activity to be used if this Sequence is not included in the Educational itinerary are also attributes in this model.

Finally, we describe the Chapter Model, whose attributes are indicated in Table 3.

As can be seen in Table 3, attributes in the Chapter Model are similar to those in Sequence and Scene Model. The only exception is the attribute *Region* which, as explained before, determines the set of Zones in which Sequences belonging to this Chapter can be developed.

To complete our system specification we need to establish the Chapters included in an EVG. We do this by the Story Model (Table 4).

5.3. Changes introduced into the general goals and tasks model

Including a new set of models to define the storytelling implies the modification of the General Goals and Tasks Model, because a relationship between the Ludic Tasks and Narrative structure needs to be defined. Thus, in Table 5 we show the General Goals and Tasks Model included, with new attributes to include the new relationships.

5.4. Graphical representation

Restrictions defined over Scenes (required, alternative, order) make a quick understanding of when they could occur difficult. A graphic representation can make their modeling and design easier and it can be considered as a storyboard representation.

In order to graphically present the EVG storytelling, we have defined a set of elements and meanings, which we explain below.

Table 2
Sequence model.

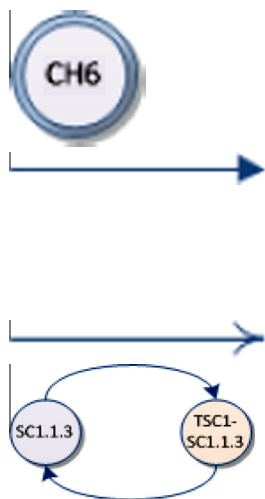| Attribute	Description	Domain
Identifier	Internal identifier	x: $x \in$ [SE00000, SE99999]
General name	General name that describes the sequence and works as a dictionary key	x: x is a General name
Narrative evolution	Description of what happens in the sequence	Natural language
Zone	This groups related Scenarios. All scenes from a sequence must take place in scenarios which are members of the same zone	x: x is a Zone
Set of scenes	Set of scenes composing the sequence	$\{x\}$: x is a scene
Previous sequences	Set of sequences which must happen before this sequence	$\{x\}$: x is a Sequence
Previous chapters	Set of chapters which must happen before this sequence	$\{x\}$: x is a Chapter
Required	This indicates whether the sequence must happen to give meaning to the story	x: $x \in$ {Yes, No}. If almost one Scene in the *Set of Scenes* is required, this Sequence is also Required
Alternative cinematic narration	If the sequence is Obligatory but its educational activities are not selected for playing, it points to a video that narrates the part of the story that the sequence tells.	x: x is a reference to a video
Alternative ludic activities	If the sequence is Obligatory but its educational activities are not selected for playing, it indicates a set of ludic activities that replaces the educational activities in the sequence	$\{x\}$: $x \in$ Phases and Levels of the game

Table 3
Chapter Model.

Attribute	Description	Domain
Identifier	Internal identifier	$x: x \in$ [CH00000, CH99999]
General name	General name that describes the chapter and works as a dictionary key	$x: x$ is a General name
Narrative evolution	Description of what happens in the chapter	Natural Language
Region	This groups related zones. All sequences from a chapter must take place in zones which are members of the same region	$x: x$ is a Region
Set of sequences	Set of sequences composing the chapter	$\{x\}: x$ is a sequence
Previous chapters	Set of chapters which must happen before this chapter	$\{x\}: x$ is a Chapter
Required	This indicates whether the chapter must happen to give meaning to the story	$x: x \in$ {Yes, No}. If almost one Sequence in the *Set of Sequences* is required, this Sequence is also Required
Alternative cinematic narration	If the chapter is obligatory but it is not selected for playing, it points to a video that narrates the part of the story that the chapter tells.	$x: x$ is a reference to a video
Alternative ludic activity	If the chapter is obligatory but its educational activities are not selected for playing, it indicates a set of ludic activities that replaces the educational activities in the chapter	$\{x\}: x \in$ Phases and Levels of the game

Table 4
Story model.

Attribute	Description	Domain
Identifier	Internal identifier	$x: x \in$ [ST00000, ST99999]
General name	General name that describes the story and works as a dictionary key	$x: x$ is a General name
Narrative evolution	Description of what happens in the story	Natural language
Set of chapters	Set of chapters composing the story	$\{x\}: x$ is a chapter

Table 5
General goals and tasks model.

Attribute	Description	Domain
Identifier	Internal identifier	$x: x \in$ [TG00000, TG99999]
Educational model	Educational model to which educational tasks included in the lower level of the model refer	$x: x$ is an educational model
Educational goals	Educational goals included in this video game	$\{x\}: x$ is a educational goal
Educational tasks and activities	Educational tasks and activities included in this video game	$\{x\}: x$ is a Educational task or activity
Video game model	Video game model to which video game tasks included in the upper level refer	$x: x$ is a video game model
Implements	List of educational tasks that implement each of the video game tasks	$\{(x, \{y\}, z)\}: x$ is a Video game task, y is an educational task, z is a formula
Story model	Defines the storytelling of the EVG	$x: x$ is a Story model
Recreates	Indicates the set of scenes occurring for every ludic task	$\{(x, \{y\})\}: x$ is a Scene, y is a video game stage and level

– To show a *required* Chapter, Sequence or Scene, we use a double-lined circle. Otherwise, single-lined circles

– Order restrictions are drawn as arrows. A hard restriction is represented as a black-filled arrow head; a soft restriction as a simple arrow head

– Twin Scenes are represented as single-lined different-colored circles doubly related to the Scene for which it is twin. A Twin Scene is named TSCn- followed by the name of the Scene for which it is twin. n, in TSCn-, is a number to distinguish Twin Scenes from the same Scene

– Alternative Scenes are also represented as single-lined, different-colored circles. They are related to the principal Scene with a dotted line, without an arrow head. Alternative Scenes are named ASC-A if the alternative is another ludic activity; or ASC-C if the alternative is a cinematic interval. Both are followed by the name of the principal Scene
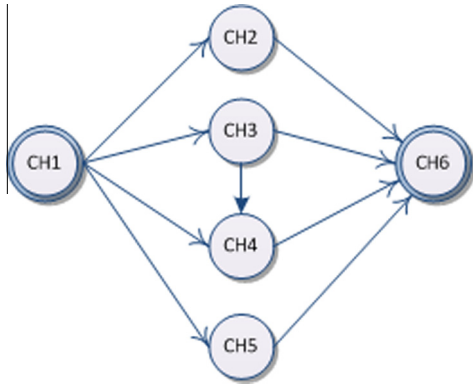
Fig. 2. Chapter organization.

6. Ato's adventure: a journey through space and time

Using the integration process presented in the previous section, we have developed an EVG called "Ato's Adventure: A journey through space and time", an iPad application aimed at children between 3 and 5 years of age. Through the game, students improve their grapho-motor skills by doing activities framed in a fantastic story that encourages imagination and brings enjoyment to the students playing. In "Ato's Adventure" the player accompanies a group of characters through different planets. In this journey, players chase the space pirates who have stolen their toys. During its development process, this game has been assessed in order to check if emotions experienced by students fulfilled our expectations. From these studies we also obtained information about

several usability aspects (Padilla-Zea et al., 2012). For example, we found that different kinds of interactions should be included due to children try both pushing and drug-and-dropping the elements in the game. In addition, students had difficulties in exercises where the more fine motor skills were required. These findings have been included as improvements in the final version of the video game.

Once we have described every model for the storytelling, and to avoid including a lot of tables here, we are going to show them as a storyboard, also explaining how elements and restrictions are represented.

As can be seen in Fig. 2, Chapters CH1 (Introducing Ato's World) and CH6 (The pirate ship) are *required*. In the first, Ato and friends are introduced and the video game's main goal is stated. In Chapter 6 that main goal is achieved. We can clearly see that those elements are crucial for the story be understood and, of course, to maintaining the interest and immersion of players.

On the other hand, Chapters CH2 Jurassic Planet, CH3 (The lord of the Triangles), CH4 (Spaceships, rust and Vinci) and CH5 (A fistful of toys) can occur in any order after CH1. In addition, there is a hard order restriction between CH3 and CH4, meaning that if CH4 occurs then CH3 has to occur before. In CH4 Ato and friends visit Leonardo Da Vinci to repair their ship which has been broken on the planet they visited in CH3. Thus, if they do not visit that planet, the ship will not break.

Finally, once the game between CH3 and CH5 is played, players arrive at CH6 to end the EVG.

As an example, we are going to focus on Chapter 1, which is composed of two Sequences, as shown in Fig. 3.

Sequence SE1.1 is mandatory (*Required*, indicated by a ∗ in Table 6) because one of its Scenes is *Required*. In this Sequence, Ato and friends are introduced as well as the world in which they live. In
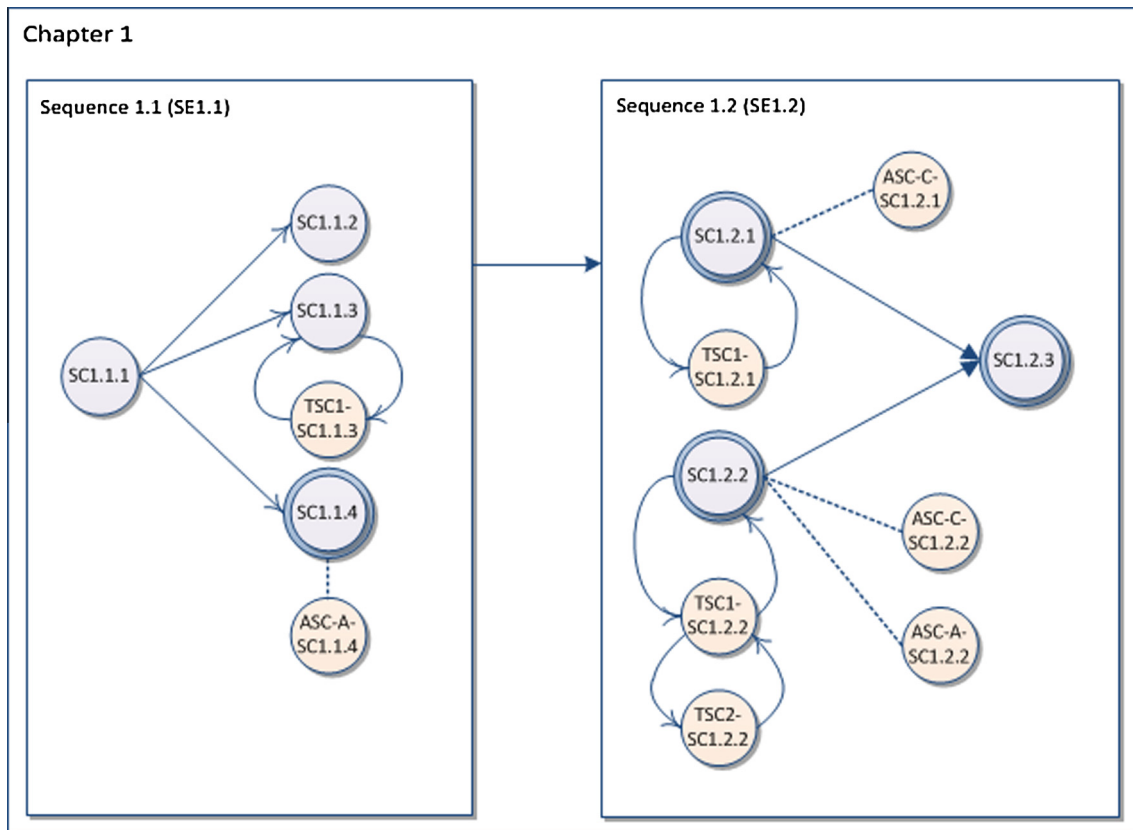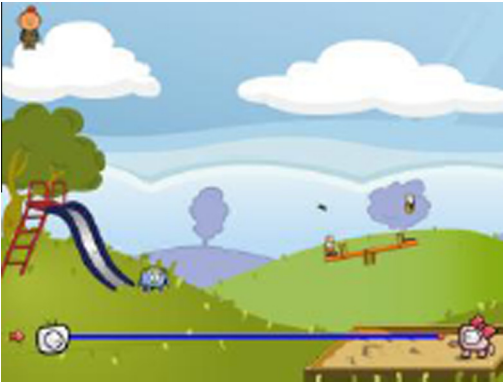

Fig. 3. Sequences and scenes in chapter 1.

Table 6
Ato's adventure storyboard.

Chapter 1: Ato's World				
Scene	Education content	Ludic content	Story content	Illustration
Sequence 1.1				
SC1.1.1			It introduces Ato and his friends	
SC1.1.2		Helping Ato to reach the sandbox in which he can play	Ato and friends spend a while playing in the fun park	
SC1.1.3		Helping Ato's friends to reach the other side of the swing	Ato and friends spend a while playing in the fun park	
TSC1-SC1.1.3	Allows SC1.1.3 to be repeated if needed		Ato's friends had a lot of fun playing this game and they want to play it again [SC1.1.3]	
SC1.1.4∗		Ato's friends want to play. We have to give them their toys	It introduces every Ato's friend's favorite toy	
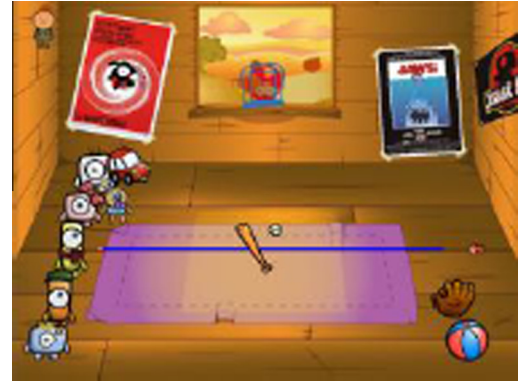
ASC-A-S1.1.4

Ato's friends want to play. We have to give them their toys

It introduces every Ato's friend's favorite toy
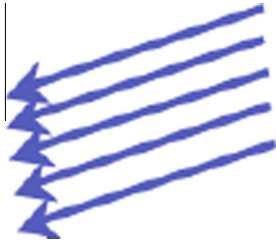
Sequence 1.2
SC1.2.1*
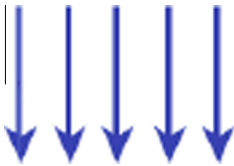
Giving Ato's friends some fruit from trees

Ato and friends have to arrange ingredients to prepare the dinner they are going to have together

TSC1-SC1.2.1

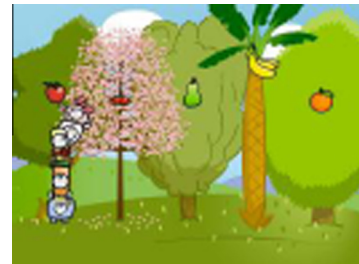Allows SC1.2.1 to be repeated if needed

While Ato's friends were washing their hands, the *glutton bear* eats fruits they have collected and they have to pick more fruits
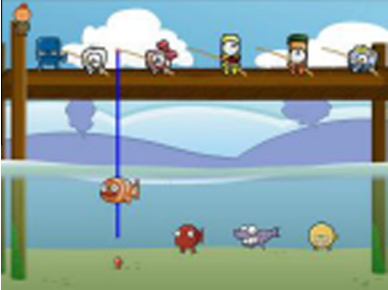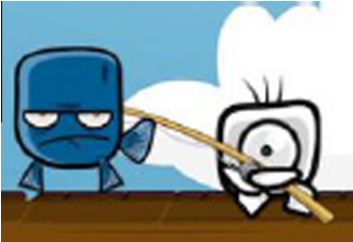

ASC-C-SC1.2.1

Replaces Story Content related to Educational Content which is not included in the game instance.

A little video in which Ato's friends pick some fruit

Table 6 (continued)

Chapter 1: Ato's World				
Scene	Education content	Ludic content	Story content	Illustration
SC1.2.2*		Fishing in the river	Ato and friends go fishing in the lake	
TSC1-SC1.2.2	Allows SC1.2.2 to be repeated if needed		When Ato's friends arrive home after fishing they realize the basket containing their fish has fallen down and they need some fish for dinner. They need to go fishing again	
TSC2-SC1.2.2	Allows SC1.2.2 to be repeated if needed		The *glutton bear* has appeared again and the fish have disappeared. They need to go fishing again	
ASC-C-SC1.2.2	Replaces Story Content related to Educational Content which is not included in the game instance.		Ato's friends are fishing for dinner	
ASC-A-SC1.2.2		Some of the fish are going to be boiled while others will be grilled. Ato's friends have to put the fish in the proper utensil		

SC1.2.3*

While Ato and friends are having dinner, Space Pirates barge into their house and steal their toys. In addition, the *glutton bear* eats the dinner

Sequence SE1.2 the problem itself is shown: several Space Pirates steal Ato and friends' toys. Between SE1.1 and SE1.2 there is an order restriction because SE1.1 has to necessarily precede SE1.2. In addition, this order restriction could be either hard or soft because both Sequences SE1.1 and SE1.2 are required.

In Sequence SE1.1 we have four Scenes. SC1.1.1 is the first one and introduces the characters; SC1.1.2, SC1.1.3 and SC1.1.4 occur after it, in any order because it depends on the decision that player makes: going to the fun park, to the swing or playing with toys at home. If the player has poorly performed the Educational Content in SC1.1.3 (making horizontal lines by helping Ato's friends to cross the swing), that Scene may have to be repeated. In that case, we have defined a Twin Scene in which Ato and friends have had a lot of fun and they want to play on the swing again. This way, repeating the exercise is integrated into the storytelling. Finally, Scene SC1.1.4 shows the favorite toy of each of Ato's friends. This Scene is important in the story because it allows the player to empathize with the video game characters. Thus, this Scene is *required*. However, the teacher may not want to train the Educational Content in the Scene. For that reason, we have included an *Alternative Scene* to practice a different Educational Content in the same narrative evolution. All these Scenes are explained in more detail in Table 6.

In Sequence SE1.2 we note that SC1.2.3 is required but it has no Alternative Scenes. This is because SC1.2.3 has no related Educational Content, thus, Educational Itineraries selected by teachers are not going to omit that Scene. Further details about the Scenes in Sequence SE1.2 are explained in Table 6.

This process of integrating the scenes with the educational and ludic objectives and tasks (defined in videogame models) is represented by using a table, which is based on the representation used in (Göbel et al., 2009), presenting the content in a similar way to that in the cinematographic language (technical screenplay). This table consists of:

- Scene: Indicates the number of the screen showing the activities.
- Educational Content: Indicates the educational content being taught or trained with that screen.
- Ludic Content: Explains how the educational content is hidden in a ludic activity.
- Narrative Evolution: Explains the role of the screen in the game's story.
- Illustration: A screen image is shown.

Table 6 shows how parts of Ato's story have been integrated with the educational and ludic activities in the game.

From the earliest stages of its development, the idea of creating a video game with a story and a series of objectives to accomplish was at the forefront of our design process. Therefore, the educational component was integrated in the game, so that the graph-motor exercises to be completed were justified in the development of the story itself. Finally, we think that this table could be a good tool to include in the Game Design Document (GDD).

7. Conclusions and future work

Including digital storytelling in EVGs is an important element in maintaining the motivation associated with the game and, therefore, with the learning process. In this paper, we have presented an extension of our design process for EVGs (Padilla-Zea, 2011) in which we model the story underpinning the EVG as a set of Scenes, Sequences and Chapters. That way we promote storytelling as requiring of more attention from the design standpoint, which provides several advantages: (1) it integrates the storytelling in the comprehensive EVG, (2) it allows adaptations to be specified according to the player's actions and educational needs, and (3) it provides mechanisms to integrate educational characteristics in the story to avoid a loss of interest. In summary, the ultimate goal is that when the player completes the game, his/her impression is to have played and been part of a story rather than thinking that he/she has been completing educational exercises. As an example, we have shown how Chapter 1 of the educational video game "Ato's Adventure" has been designed under our proposed method.

Our immediate future work consists in designing a new video game in which every conclusion previously stated are included and assessing it. This design process will be performed on the base of the user-centered design proposal, it is said, early assessments will be realized in order to obtain the best possible results, specially referring to storytelling development and its influence in players' emotions.

Acknowledgements

References

Bopp, M. M. (2008). Storytelling and motivation in serious games. *Part of the Final Consolidated Research Report of the Enhanced Learning Experience and Knowledge Transfer – Project ELEKTRA* <http://www.elektra-project.org/>, a project supported by the European Commission (contract number 027986).

Cavazza, M., Charles, F., & Mead, S. J. (2002). Character-based interactive storytelling. *IEEE Intelligent Systems, 17*(4), 17–24.

Champagnat, R., Delmas, G., & Augeraud, M. (2010). A storytelling model for educational games: Hero's interactive journey. *International of Journal of Technology Enhaced Learning, 2*(1/2), 4–20.

Felicia, P. (2009). *Digital games in schools: A handbook for teachers*. European schoolnet.

Göbel, S., de Carvalho Rodrigues, A., Mehm, F., & Steinmetz, R. (2009). Narrative game-based learning objects for story-based digital educational games. In *Proceedings of the 1st int. open workshop on intelligent personalization and adaptation in digital educational games* (pp. 43–53).

Grove, De., Bourgonjon, J., & Van Looy, J. (2012). Digital games in the classroom? A contextual approach to teachers' adoption intention of digital games in formal education. *Computers in Human Behaviour, 28*, 2023–2033.

Ibrahim, A., Gutierrez, F. L., Paderewski, P., González, J. L., & Padilla-Zea, N. (2012). Playability guidelines for educational video games: A comprehensive and integrated literature review. *International Journal of Game-Based Learning, 2*(4), 18–40.

Law, E. L., & Kickmeier-Rust, M. (2008). *80Days: Immersive digital educational games with adaptive storytelling*. Proceedings of the First International Workshop on Story-Telling and Educational Games.

Lugri, J. L. & Cavazza, M. (2006). AI-based world behaviour for emergent narratives. In *Proceedings of the 2006 ACM SIGCHI international conference on advances in computer entertainment technology*.

Merril, M. D. (2002). First principles of instruction. *Educational Technology research and Developments, 50*, 43–59.

Merabti, M., El Rhalibi, A., Shen, Y., Daniel, J., Melendez, A., & Price, M. (2008). Interactive storytelling: approaches and techniques to achieve dynamic stories. *LNCS, 5080*, 118–134.

Michael, M., & Chen, S. (2006). *Serious games: Games that educate, train and inform*. Boston, MA: Thomson Course Technology.

Moreno-Ger, P., Burgos, D., Martínez-Ortiz, I., Sierra, J. L., & Fernández-Manjón, B. (2008). Educational game design for online education. *Computers in Human Behaviour, 24*, 2530–2540.

Padilla-Zea, N. (2011). *Metodología para el diseño de videojuegos educativos sobre una arquitectura para el análisis del aprendizaje colaborativo. PhD dissertation*. Spain: University of Granada.

Padilla-Zea, N., González-Sánchez, J. L., Gutiérrez, F. L., Cabrera, M. J., & Paderewski, P. (2009). Design of educational multiplayer video games: A vision from collaborative learning. *Advances in engineering Software, 40*(12), 1251–1260.

Padilla-Zea, N., Medina, N., Gutiérrez, F. L., & Paderewski, P. (2011). A model-based approach to designing educational multiplayer video games. Technology-Enhanced Systems and Tools (pp. 167–191). Berlin: Springer-Berlag.

Padilla-Zea, N., González-Sánchez, J. L., Gutiérrez, F. L., Abad. Arranz A., & López-Arcos, J. R. (2012). Evaluating emotions in educational videogames. the particular case of children. In ACM International Conference Proceeding Series, Article no. 42.

Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.

Sauvé, L. (2009). Design tools for online educational games: Concepts and application. *Lecture Notes on Computer Science, 5660*, 187–202.

Tran, C. D., George, S., & Marfisi-Schottman, I. (2010). EDoS: An authoring environment for serious games. In *Design based on three models. Proceedings of the 4th European Conference on Game-Based, Learning* (pp. 393–402).